

Eating for Your Best Brain

*Enhancing Cognitive Abilities through
Nutrition*



Eating for Your Best Brain

Enhancing cognitive abilities through nutrition

Darlene Birch

Dietician Nutritionist

Liz Weaver

Learning Success

Foreword by Phil Weaver

© Learning Success 2016

Foreword

Why This Book?

Parents today struggle in so many ways. Parents of the struggling learner have it so much worse.

Each and every day we talk to parents of struggling learners and they all have one thing in common.

Exhaustion!

They've battled homework time.

They've struggled to get help for their child.

They have worried and worried and worried. Often building up their own anxieties so much that their own health and sanity is at risk.

The more a parent worries and searches for answers the more they want the easy button. Do this one thing and it will all be solved.

Well there is no easy button. But don't let that dismay you. There is help, and it's not difficult or expensive. You can do this! It's not as hard as you think.

Before we created the Learning Success System (www.learningsuccesssystem.com) we made a pretty big discovery. We were, and are, kung fu teachers. We reach a very rare form of kung fu called Shou' Shu'. We found that in many circumstances, children with learning difficulties would improve in academics when they trained with us.

Over and over parents would report back that their struggling child's grades were improving.

Now that may sound like a lot of woo woo but I encourage you to read on.

It turns out there was a reason for what was happening. It turns out that coordination and proprioception are very connected to focus, emotions, visualization, and logical thinking. Plus the discipline and following directions didn't hurt either. There were a lot of reasons that kids started improving. Some known. Others not so well understood.

That's all way beyond the scope of this book, if you want to read up on it you can find that information at www.learningsuccessblog.com

When I say we discovered this connection I'm stretching the truth just a bit. In actuality much of the credit goes to a man by the name of Jack Pickens. Jack was one of the best elementary school principals you could ever meet. He was a master Jedi at communicating with the kids and getting them on the right track. He was a taskmaster (so is Liz) but the kids respected him and wanted to please him by doing well (same with Liz). Over the years I watched "Shifu" Liz develop these same skills. She was a born disciplinarian. She gets it from her father. But she learned to connect. The two skills together are magical.

Jack, after signing his own daughter up with us, educated us on the benefits of bilateral coordination exercises, coordination, and proprioception. These were things we were teaching, but didn't even know we were teaching. To us it was just Shou' Shu'.

Jack had seen us doing demonstrations at his school. At a school event he had founded. It was a fine arts festival Jack had designed to bring sensory activities into the school. That Jack was a clever guy.

Anyway, Jack saw what we were doing and wanted that for his daughter. Then he wanted it for lots of other kids under his care.

Jack, being principal of the local elementary school, sent us every ADHD kid, every dyslexic, and every other child having a learning difficulty under his care. I don't think dyscalculia, dysgraphia, or even Aspergers were really known about at that time, but I'm sure he sent those kids too. He told the parents to bring their child to us and they did. People did what Jack suggested.

So not only did we get educated but we got experienced. Very, very experienced. Thanks Jack :-)

I suppose that at that time we could have proclaimed that we had the miracle cure. But we didn't proclaim anything. We just kept doing what we were doing. Actually we were still a little perplexed. We knew what we were seeing. Kids becoming better learners. After about 10 years of seeing it, it became pretty commonplace for us.

A parent would come in beaming about their child's progress. We'd just say:

"Oh yeah, that's the Shou' Shu', happens all the time"

We knew there was more going on than we knew. Actually even today that's still true. But hey, if it works, keep doing it.

Eventually we connected with an educational therapist. We compared what we were doing with ideas from educational therapy. There was a definite connection. Educational therapy, going way back, has had these ideas of cross lateral motions and coordination. It had been known that these were beneficial but no one in the educational therapy field was an expert in body mechanics. So the field used simplistic cross lateral motions. Cross crawls and figure eights. We knew we could do better than that.

Recognizing the connection we formed a partnership with an educational therapist. We were to bring in the expertise in body mechanics and combine this with ideas from educational therapy. A new concept and a new product was born.

We had some limited success with the product. Many reported back that it had helped their child immensely. Yet not in the numbers we expected. Despite our grand efforts that first product was flawed.

The problem was that it was missing a lot. Over several years of talking to parents we figured out the problems and solved them.

1. Our body mechanics expertise did not make it into the first product. We had not put in what we already knew worked. We relied too much on old school educational therapy.
2. Liz's self confidence building skills had not been put in.

3. A one size fits all approach is not ideal.
4. Parents got overwhelmed
5. The program was too much too fast. It didn't utilize the principle of Kaizen (small steps)
6. Developing proper attitude through proper praise (yes you can praise incorrectly and improper praise can cause a lot of problems)

All of the above has been solved in the new Learning Success System
(www.learningsuccesssystem.com)

But there is one more thing. In some cases that thing can make it or break it. In other cases it's a minor element. Either way, it should be addressed.

What is it?

Nutrition

How do we solve it?

Well that's what this book is about. Nutrition is the element of enhancing cognitive ability that gets little attention. In a world of push button solutions sometimes the basics get left out. This is our solution to solving that.

How about we get started.

Let's start out with the following idea in mind:

Nutrition is a journey

Lots of destinations

But if you never get started, well....you just stay where you are.

This book is a start. Your child's nutritional journey may go to many strange places. Unexpected places. Ours did. But no matter what. It's getting started that counts. Ideas don't do things. People do things.

So even if that start is something tiny. It doesn't matter. It's a start. That's the learning success way. Small steps.

Expectations

In starting this nutritional journey there are two possibilities:

1. There is a food reaction going on.

There are cases where a food reaction is causing all or at least a substantial part of the problem. Find this food and solve the problem

- 2) Optimization

If you are trying to help the brain develop into a new and better brain then you've got to feed it the right stuff.

Two help you on this journey we've prepared two books. This one, which will give you a good overview of nutrition for the brain. You'll learn all the hows and whys.

But if you want to just jump to it we've got you covered. We've created a cookbook. Simple easy recipes your child will love, have none of the common allergens, and are packed with nutrition to keep the brain going all day long.

If you want to jump to that you can download it [here](#)

[Feed Your Child's Brain Cookbook](#)

Or

If you want to know all the whys and hows, read this first. It's a condensed overview of nutrition and how it relates to cognitive ability.

Enjoy the book and get started on a healthier brain

Phil Weaver

Learning Success

TABLE OF CONTENTS

Chapter 1: Nutrition Basics of the Brain.....	page 2
Chapter 2: Macronutrients.....	page 6
Chapter 3: Micronutrients.....	page 19
Chapter 4: Putting it All Together.....	page 31
Chapter 5: Controversial Ingredients.....	page 33
Chapter 6: The Big Picture.....	page 38
Chapter 7: Nutritional Concepts.....	page 41
Glossary.....	page 43

Chapter 1: Nutrition Basics

How Nutrition Fuels the Brain

Glucose: The Brain's Energy

The brain is the most important organ of the body. It controls all functions inside the body. That's why it's important to make sure it's getting the proper nutrition. But first, let's understand how nutrients get to the brain.

The brain's only form of energy is glucose which is a simple sugar. In order to get it to the brain, the body digests the foods that we eat and turns them into glucose. The biggest source of glucose for the brain are carbohydrates because they are easily turned into glucose. The brain then uses the glucose to make the right proteins and fats to grow and develop both the brain and the body.

In order for your body to make new proteins & fats, it first needs to digest protein and fats from the food that you eat. It's an exchange- in order for the brain to make fats and proteins for the body, the brain needs glucose. And in order for the brain to function, the body needs to digest the appropriate fats and proteins for the brain.

Although glucose is the sole energy source for the brain, the brain still needs nutrients like vitamins, minerals, and other chemicals to work. If you do not have the correct balance of these nutrients, then your brain will not work correctly. Too little or too much of any one nutrient can affect the entire nervous system and hurt the body.

How Nutrients Enter the Brain

But how does a nutrient make it to the brain? The pathway that a nutrient follows to get into the brain is not easy. Before a nutrient enters the brain, it undergoes a series of steps.

1. Once a nutrient is eaten, it travels into the stomach where it sits in the stomach acid that breaks down food.
2. If it hasn't been dissolved by the stomach acid, the nutrient then goes into the digestive tract and gets absorbed through the cells that line the intestines. Once absorbed, the nutrient is transported through the blood vessels' wall and into the bloodstream.
3. Once in the bloodstream, the nutrient crosses small blood vessels into the brain tissue. The transportation from the blood to the brain tissue is regulated by the blood brain barrier.

The Blood Brain Barrier

The blood brain barrier is responsible for watching which nutrients enter, or stay out of, the brain. The blood brain barrier is like a wall between the bloodstream and neurons inside the brain

tissue. In order for a substance to get through, it must cross this wall from the blood to the neurons. There are three ways a substance can cross the blood brain barrier.

1. Some nutrients fit through “holes” in the barrier.
2. Some nutrients are transported through the barrier by special carriers.
3. Some nutrients can actually break down the barrier.

The Blood Brain Barrier: The Border Analogy

The blood brain barrier can be thought of like the border which separates the United States from Mexico. The officers that monitor the border check passports, inspect vehicles, and ensure that everything is fine before letting someone enter or leave the United States.

Someone who has all of the appropriate paperwork simply shows the officer their documents and can freely cross back and forth between the United States and Mexico. This manner of crossing is like that of the nutrient that fits through the holes of the blood brain barrier. Not all the nutrients can fit, in the same way that not everyone can freely cross the border. But if you do fit the hole, then you cross freely back and forth.

Now if an individual is trying to get into the United States, but lacks the proper documentation, they may try to hide in a vehicle that carries them across the border. This is similar to the way that a special carrier would carry a nutrient across the blood brain barrier. The individual lacking the appropriate paperwork needs a carrier that can take them across the border in the same way that certain nutrients need a special carrier to help them cross the blood brain barrier.

There are also people who cross the U.S. border that lack both paperwork and a carrier. For these individuals, one of their options is to actually travel to an isolated portion of the border fence and cut holes into it to cross. In the same way that a person wanting to enter the United States might “break down” the border, some nutrients can actually break down the blood brain barrier and cross into the brain.

The Importance of Nutrition for Brain Function

Given the amount of work it takes for nutrients to cross into the brain, it may seem like the brain doesn’t want nutrients to enter in the first place. But this simply isn’t the case. Because the brain is such an important organ, the body must monitor what nutrients are crossing the barrier in order to keep the brain safe.

Although the brain only accounts for 2% of total body mass, it uses between 20% – 30% of the body’s daily energy intake. This shows that the brain is a very demanding organ. Therefore,

proper nutrition, and a lack thereof, can greatly impact brain chemistry and overall neural function. Even skipping one meal can have immediately detrimental impacts on brain function. Studies have shown that students who don't eat breakfast are less able to focus, and don't perform as well, compared to their peers who have eaten breakfast. Needless to say, nutrition can impact one's overall mood, sleeping ability, and cognitive function.

Brain Health: Important from Conception

From the point of conception, brain development is vital. Between the tenth and eighteenth week of pregnancy, the brain grows rapidly in the fetus. That's why it's important for the mother to make sure she is getting the right nutrition during this time. Just before birth through the first two years of life, the brain grows rapidly. This means that malnutrition, especially from fetal growth through two years of age, can have a devastating impact on the nervous system.

Mothers who have poor diets during pregnancy risk giving birth to infants with mental retardation or behavioral problems. In addition, children who do not receive adequate nutrition in their first few years of life may develop problems later on. Luckily, some of the negative effects of malnutrition can be repaired by a proper diet but it depends on the span of time during which the malnutrition occurred and in what stage of development it occurred. Malnutrition during childhood has been associated with low intelligence and cognitive defects.

The nutritional factors that impact mental health include how much one eats (i.e. energy intake) and what type of energy was consumed (i.e. carbohydrates, proteins, fats, vitamins and minerals). Generally, it is the lack of several nutrients rather than one single nutrient that results in the deterioration of the brain. Continual hunger and starvation massively changes mental responsiveness. The body will first slow down most, if not all, non-essential functions. Reduced hormonal activity, oxygen transport, and immune efficiency are among the few consequences that result from poor nutrition and ultimately affect brain function. In fact, individuals with continually low energy intake often feel apathetic, sad, and depressed.

Conclusion

The brain is a vital organ that demands a large portion of the body's energy supply despite its size. Because the brain is the organ that is vital for controlling the entire body, it is important to make sure it gets the proper nutrition. The body ensures that the brain receives the right nutrition by utilizing the blood brain barrier which is responsible for regulating which nutrients cross from the body to the brain. If proper nutrition isn't being eaten, then the efficacy of this barrier is impaired and inevitably, the brain will be starved. Mood disorders and impaired cognitive function within the brain are among the few negative impacts that can result from poor nutrition.

Chapter 2: Macronutrients

How carbohydrates, proteins & fats are used by the brain

Introduction

Macronutrients can be defined as those nutrients that provide calories, also known as energy, to the body. In addition, macronutrients are those nutrients needed in large amounts by the body. There are three macronutrients: carbohydrates, proteins and fats. This chapter discusses the importance of each macronutrient and its impact on brain function.

Carbohydrates

Carbohydrates are found in grains such as cereal, rice and pasta. They are also found in fruits, vegetables, peas, beans, and dairy products. Ultimately, carbohydrates exist in all foods with the exception of meat.

There are two types of carbohydrates:

1. Simple Carbohydrates – sugars that are made up of one or two sugar molecules.
2. Complex Carbohydrates – sugar molecules that have been strung together to form a larger molecule.

Complex carbohydrates can be found in grain products such as whole wheat bread, whole wheat pasta, and brown rice. Fiber and starches are examples of complex carbohydrates and are also found in whole grain products along with fruits and vegetables. Simple carbohydrates are small sugar molecules. Simple carbohydrates, that are also natural, are found in fruits, vegetables, and dairy products. Refined sugars, like those found in sodas, candy and many desserts, have been processed so much that they have no beneficial nutrients. Refined sugars are not natural and are not ideal. Refined sugars should be avoided. The only thing that a refined sugar will contribute to the body is calories while a natural sugar, which already exists in an apple, will come with vitamins, minerals and antioxidants which are good for the body.

Carbohydrates are the main source of blood glucose, which is responsible for energizing all of your body's cells. As mentioned in Chapter 1, it is also the only source of energy for your brain. Although glucose can be produced from fats and proteins, the body prefers to make glucose from carbohydrates. Glucose can either be used immediately by the body or stored in the liver as glycogen where it is later broken down into glucose when needed.

Are Carbohydrates the Enemy of My Brain?

There are many diets out there that advocate conflicting dietary philosophies. Some encourage a low carbohydrate, high protein diet while others encourage a diet high in whole grains, fruits, and vegetables while limiting protein intake. Some diets demonize carbohydrates while others

celebrate them as the advent to modern civilization. So how do you decide if carbohydrates are good for your brain?

Grain Brain, written by Dr. Perlmutter, infamously placed carbohydrates as the culprit to many neurological disorders. In his book, Perlmutter argues that this food group is destroying our brain by causing dementia, ADHD, anxiety, chronic headaches, depression and much more. As a neurologist, he swears by the efficacy of a low carbohydrate, high protein diet in improving the mental well being of his patients. Dr. Perlmutter's peers, however, argue that while these diets are highly effective in treating numerous psychological ailments, there is no evidence demonstrating that a low carbohydrate, high protein diet is preventative for psychological disorders. In other words, just because a low carbohydrate, high protein diet may help in treating depression, it does not mean that it will prevent depression nor does the absence of carbohydrates in this effective treatment mean that carbohydrates cause depression.

In fact, some archeologists argue that it was our consumption of grains, and carbohydrates in general, that allowed us to evolve into Homo sapiens in the first place because this food source is readily converted into glucose within the body. Even in today's world, there are societies known for their long life spans where carbohydrate food sources make up a predominant portion of the diet. A prime example of this is the Okinawans of Japan who eat a plant-based diet.

Given the current research, there is little evidence that supports the notion that carbohydrates are bad for our brains. So unless there's a known food allergy, autoimmune condition, or other health condition, then you don't need to avoid carbohydrates.

Complex Carbohydrates: Best for the Brain

As previously mentioned, fiber and starch are examples of complex carbohydrates and can be found in whole grain products, fruits and vegetables. Research shows that complex carbohydrates are the best carbohydrate option from which to make glucose. This is because complex carbohydrates need to be digested and broken down by the body in order to extract and make glucose. Because of the work that the body needs to do in order to get glucose from complex carbohydrates, most complex carbohydrates are low on the glycemic index. This means that they are digested slowly by the body which results in a slow and steady release of glucose to the brain over a longer period of time.

In addition, the fiber found in whole grains, fruits, and vegetables improve heart and digestive health because they help keep cholesterol low which ultimately helps blood flow to the brain and other organs as well.

It is for these reasons that complex carbohydrates are the recommended source of carbohydrates for the brain.

Simple Carbohydrates – Natural Sugars: Good for the Brain

To reiterate, simple carbohydrates are sugars that contain only one to two sugar molecules. For example, fructose and sucrose are simple carbohydrates. Generally speaking, simple carbohydrates are not ideal for the body because they are easily digested and absorbed. This means that the resulting glucose can be quickly delivered to the brain and body. This also means that generally speaking, simple carbohydrates are high on the Glycemic Index because of the quick digestion that results in a fast release of glucose to the brain over a short period of time. While this sounds great, a sudden surge of glucose to the brain can impair brain function. Natural sugars, however, are good for the body despite the fact that they are simple carbohydrates.

Earlier we stated that fruits and vegetables contain natural sugars. These natural sugars are good for the brain because the fruit and vegetables that they're found in have beneficial nutrients like vitamins, minerals, and antioxidants. So while the sugar itself may not be nutritionally beneficial for the body since it only contributes calories, it comes with added nutrition because it's in the fruit and vegetable themselves.

Simple Carbohydrates – Refined Sugars: Bad for the Brain

Simple refined carbohydrates are detrimental to the brain because they are, as the name implies, simple. Like their natural counterparts, refined sugars are quickly digested by the body and the resulting glucose is quickly delivered to the brain. The sudden rush of glucose to the brain can then result in impaired brain function.

What makes refined sugars worse than natural sugars is the fact that they have been processed to such an extent that they provide no additional nutrition outside of calories. Remember that natural sugars are found in fruits and vegetables. This means that they are accompanied by antioxidants, vitamins, and minerals which are needed by the brain and body. Refined sugars, on the other hand, do not come with additional nutrition because they are used with the intention of being added to foods. Therefore, refined sugars are not ideal for the brain or body. Examples of refined sugars include table sugar, corn syrup, and high fructose corn syrup.

Glucose: How Much is Too Much?

The Institute of Medicine sets the recommended daily allowance at 130 grams of carbohydrates per day to supply the brain with all of the glucose that it needs. These calculations, however, do not account for the glucose that can be produced from the fat and protein that we eat.

At the end of the day, the amount of glucose required by the brain varies with the individual. One's metabolism, and the amount of glucose in their brains prior to eating, factor into determining how much glucose they need. And because the amount of glucose needed by the

brain is still hotly debated, it's simply not worth stressing over especially if you're new to the world of nutrition and are just embarking on your journey towards optimized nutrition. Instead, focus on eating a balanced diet full of nutrients as a means to ensure that the brain gets the right amount of glucose that it needs.

Your Body is a Mansion: A Simple Analogy

To understand how carbohydrates work in your body, it's best to think of it as a mansion. Mansions are large structures full of many rooms. Although these large, impressive houses are "simple" in concept, the truth of the matter is that keeping a mansion well maintained and running smoothly is a complicated task- not unlike the human body.

When placing the human body in the context of a mansion, it's best to think of carbohydrates as the electricity. In other words, carbohydrates are the energy that allows the body's operations to run smoothly in the same way that electricity allows the mansion's operations to run smoothly. Carbohydrates are the main and preferred source of energy for the human body in the same way that electricity provides the power needed by the house in order to ensure it stays clean and well maintained.

Think about the important role that electricity plays for the mansion. Electricity provides the power needed to light the mansion. It also gives the mansion's staff the ability to clean and maintain the mansion and its property. Electricity allows the maid to power the vacuum so that the carpets and rugs can be cleaned. It also gives the gardener the ability to trim the hedges and lets the butler use the electric stove to heat up water for afternoon tea.

Needless to say, without electricity the staff would not be able to clean and maintain the mansion property. As a result, the mansion would slowly get dusty, dirty and inevitably, fall apart. This is just like the body which would fall apart if it didn't get the energy it needs from food, especially carbohydrates.

Protein: Important for the Body

Most Americans understand that protein is important for the body. When protein is brought up in conversation, people probably think of how human hair and nails are pure, concentrated protein. Most people probably think of building muscle when they think of protein since many people believe that you need to eat more protein when you are trying to build muscle.

The truth of the matter is that while proteins play a vital role in the body, most Americans get enough protein in their daily diet and don't need to eat more even when they are exercising more. In fact, the typical American diet is high in protein and most Americans could stand to eat less of it in their diet. So while proteins are important for both the body and the brain, most of us won't have to worry about being protein deficient.

Individuals following a vegetarian diet may want to consult a dietitian to make sure they are getting adequate amounts of protein. As we'll learn later on, protein plays a vital role in the body and while many of us understand that the body needs protein, few of us probably know why protein is important for the body.

Amino Acids: The Building Blocks of Protein

When most of us think about the term 'protein', we often think of meat like chicken, pork and beef. Most of us know that protein is the necessary nutrient for building and maintaining muscle. And frankly put, as Americans, we love the stuff. After all, steak, burgers, hot dogs, fried chicken, pork chops and ribs are staple meats in the American diet.

What you may not know, however, is that the term 'protein' refers to a larger compound that is comprised of smaller compounds called amino acids. The average American has probably seen the term 'amino acid' used in some form on the packaging of the protein supplements sold in vitamin and supplement shops.

Simply put, amino acids are the organic compounds that combine to form proteins. But why should you care that amino acids are the compounds that form and create a protein? You should care because amino acids are the building blocks of protein.

Not only do amino acids combine to form proteins but they are also intermediates in metabolism. This means that they catalyze (start) almost all of the chemical reactions that take place within a living cell. This catalyzation is the result of the work performed by an enzyme, which is a protein. Amino acids also control virtually all cellular processes. And ultimately, it is the chemical properties of the individual amino acids comprising a protein, along with the order in which these amino acids line up, that determines the biological activity of the protein, its three dimensional structure, and the resulting stability of the protein structure.

For simplicity's sake, we are going to say that there are twenty amino acids total, eleven of which are produced by the human body. The other nine must be supplied through the diet. This makes them essential amino acids.

Failure to obtain enough of even one of these nine essential amino acids will result in the degradation of the body's proteins – muscles and the like – to obtain the one amino acid that is needed. And unlike fat and starch, the human body does not store excess amino acids for later use. The body does one of two things with excess protein- it either breaks it down immediately for energy or it gets rid of the protein through the urine. And while the body does not store excess protein, it does store the excess calories from the protein...as fat.

As stated earlier, the truth of the matter is that the American diet is inherently high in protein. Most of us eat enough protein on a daily basis to meet the body's protein needs. This is good news because it means that the likelihood you're missing out on one of the nine essential amino acids is slim. Therefore, you probably don't need to worry about your body breaking down your muscle and organ tissue to meet its protein needs.

Amino Acids in the Brain

As it relates to the brain, amino acids can be used to create neurotransmitters. Neurotransmitters are chemical messengers that send signals from one nerve cell to another. Neurological and mental disorders may occur if the balance of neurotransmitters is off.

Shown below is a table listing a few examples of amino acids that are used to make neurotransmitters. It also shows dietary sources for each amino acid listed.

Amino Acid	Neurotransmitter	Dietary Sources
Aspartic Acid	Aspartate	Peanuts, potatoes, eggs & grains
Choline	Acetylcholine	Eggs, liver & soybeans
Glutamic Acid	Glutamate	Flour & potatoes
Phenylalanine	Dopamine	Beets, soybeans, almonds, eggs, meats & grains
Tryptophan	Serotonin	Eggs, meats, skim milk, bananas, yogurt, milk & cheese
Tyrosine	Norepinephrine	Milk, meat, fish & legumes

The above table demonstrates that amino acids come from the food that people eat and drink. The amino acids are then used by the body for different purposes. The neurotransmitter called serotonin, which is important for sleep, is made from the amino acid tryptophan. Tryptophan can be found in eggs, milk and bananas so if you're having a hard time going to bed, it's possible that a glass of milk before bed will help ease you into sleep.

In the same manner that the body will take amino acids to build a protein, the body also takes proteins and breaks them down into their individual amino acid components. Shown below is a table listing the essential and non-essential amino acids. Essential amino acids are not created by the body and therefore, must be obtained from the diet. Non-essential amino acids are those that the body can make and therefore, do not need to be eaten.

Essential Amino Acids (not produced in the body)	Nonessential Amino Acids (produced in the body)
Histidine	Alanine
Isoleucine	Arginine*
Leucine	Asparagine
Lysine	Aspartic Acid
Methionine	Cysteine*
Phenylalanine	Glutamic Acid
Threonine	Glutamine*
Tryptophan	Glycine*
Valine	Proline*
	Serine*
	Tyrosine*

* essential only in certain cases

The danger in being deficient in an essential amino acid is the fact that if you are deficient for a long enough time, then your body will be unable to build more protein. This will impact your body's ability to heal and function properly.

Your Body is a Mansion: A Simple Analogy Continued

We previously discussed how the human body is like a mansion. In this mansion, carbohydrates function like electricity. They are the primary source of energy that powers most of the appliances in the mansion. Without electricity, the mansion stays dark and it will eventually fall apart.

But it's not enough for the mansion to have power in the form of electricity. In order for a mansion to last, it needs to have a strong structural framework. This is where amino acids come into play. Amino acids are the framework of the mansion, the building blocks upon which everything else is built.

Recall your childhood days when you used to eat alphabet soup. Proteins have a specific spelling in the same way that words need to be spelled in a certain way so that we know what they are and what they mean. Therefore, amino acids are like the individual letters that are strung together to make a word.

In the same way that the order of the letters determines what word is spelled and what it means, the manner in which the frame of the mansion is laid down determines how the mansion will look. After all, the human body is 20% protein just like how the frame of a mansion is not a majority of the materials that comprise it, but it has a tremendous impact on the shape, size and functionality of the mansion.

And if the framework of the mansion is not well planned, and it's weak, then the overall flow, function, and safety of the mansion are compromised. A weak framework not only jeopardizes the inhabitants of the mansion but it could also impact other elements of the mansion as well. That's why it's important to make sure the framework of the mansion is well built and maintained. In the same way, the body uses amino acids to build proteins which work together to form the frame of the body.

The Skinny on Fat

Given all of the negative attention that fat receives in the media, it's easy to believe that fat is evil and that the body doesn't need it. But the truth is that the body does need fat. Like protein, however, the average American doesn't need to go out of their way to get fat into their diet.

Fat is used by the body for a number of different reasons. Fat's primary role in the body is to function as stored energy. In fact, fat is the most concentrated form of energy providing 9 calories/gram compared to 4 calories per gram for protein and 4 calories/gram for carbohydrates. Therefore, fat is a resource for calories when the body is running low on energy.

Fat Saves You in the Mad Rush of Life

Say you've had a busy day that got started on the wrong foot. You overslept and in the mad rush to make it out the door, you didn't eat breakfast. With back-to-back meetings in the office and a large project due tomorrow, you also skip lunch. And since you had a deadline to meet, you decided to stay late at work and miss dinner.

While the practice of skipping meals is never ideal, it's important to understand how your body is able to keep itself running during these moments of isolated "starvation". Where does your body obtain the energy it needs to keep itself running while you busily work and deprive the body of food? Look no further than fat. The fat stores in your body are what provides it with the energy it needs to keep you alive.

Vitamins Need Fat

Fat is also needed for the digestion and storage of certain vitamins. There are two classes of vitamins, fat-soluble vitamins and water-soluble vitamins. Fat-soluble vitamins need fat to be present in order to be digested and absorbed. Without fat, the body cannot obtain these vitamins. Vitamins D, E, K, and A are the four fat-soluble vitamins. All of the other vitamins are water-soluble.

Fat and Brain Development

Fat is more than just stored energy and the means by which fat-soluble vitamins are absorbed. Fat is also important for normal brain development. If you were to weigh the brain, its dry weight would be about 60% fat. Both omega-3 and omega-6 fatty acids would account for about 20% of that fat weight. This clearly shows how important fat is for the brain and demonstrates the important role that omega-3 and omega-6 fatty acids play in overall brain health.

The Different Types of Fat

In the science world, fats are referred to as fatty acids. Moving forward, this is how they will be referenced in this book. There are five major categories of fatty acids.

1. Saturated Fatty Acids:

Saturated fatty acids include any fat that stays solid at room temperature. Think of butter or the fat marbled throughout a piece of steak. When at room temperature, the fat is still solid, even if it's soft. And if it's solid at room temperature, then it's likely to be solid in the arteries of the body.

Saturated fats are found mostly in animal products like meat and dairy. But there are also naturally occurring plant-based saturated fatty acids like palm oil or coconut oil. Next time you walk down your grocery store aisle, look for coconut oil and you will see that depending on the temperature of the store, the oil is either a solid or a liquid. Usually, it's a combination of both.

Most Americans eat too much saturated fat which can contribute to high cholesterol levels in the body. It's always important to actively work towards limiting this specific fat type as much as possible.

2. Polyunsaturated Fatty Acids:

Polyunsaturated fats are fats that are liquid at room temperature like vegetable oils. These fats help lower LDL ("bad") cholesterol levels and raise HDL ("good") cholesterol levels in the body. Polyunsaturated fats can be found in corn oil, soybean oil, safflower oil, sunflower oil, nuts, seeds and salad dressings.

3. Monounsaturated Fats:

Like polyunsaturated fats, monounsaturated fats are liquid at room temperature. And like their polyunsaturated counterparts, monounsaturated fats lower LDL cholesterol levels in the body. Good sources of monounsaturated fatty acids include avocados, olive oil, peanut oil, sesame oil, natural peanut butter, olives, sesame seeds and most nuts.

4. Trans-fatty Acids:

It's best to think of trans-fatty acids as a science experiment gone awry. A trans-fat occurs when oil is taken and pummeled with hydrogen atoms until it becomes solid at

room temperature. This is how vegetable shortening (Crisco) is made. The vegetable oil is taken and continually blasted with hydrogen atoms until it becomes a solid.

Trans-fats were first created as a means to extend the shelf-life of food. With the industrialization of the country, citizens had less and less time to devote towards cooking. As a result, supermarkets began to get flooded with processed foods all promising to make meal preparation both easier and faster. And it did exactly that.

In an effort to maximize profits, trans-fats became favorable because they could extend the shelf life of a product but also improved the overall product quality. Trans-fats allowed for flakier crusts and softer cookies. As a result, trans-fats are in many baked goods ranging from cookies and donuts to pie crusts and pizza crusts.

But the story of trans-fats doesn't end as the savior for food manufacturers. The issue with trans-fats is that because they aren't naturally occurring, the human body does not know how to metabolize this "nutrient". So when the body sees a trans-fat, it does absolutely nothing with it. Exposure to trans-fat can result in a deformed cellular structure within the cell.

5. Essential Fatty Acids:

Like an essential amino acid, essential fatty acids are those that are not made in the body and therefore, must be obtained through the diet. The good news is that some foods that are naturally good sources of monounsaturated and polyunsaturated fatty acids are also good sources of EFAs (essential fatty acids). Within the EFA family, there are two classes: Omega-3 and Omega-6.

NOTE: Omega-9 is another necessary fatty acid but because the body can make it when it has enough omega-3 and omega-6 fatty acids, then it's considered a non-essential fatty acid.

EFAs are used in the body to support the cardiovascular, reproductive, immune and nervous systems. They are also used to make and repair cellular membranes which monitor what enters and leaves the cell. EFAs make prostaglandins which help regulate body functions including heart rate, blood pressure, and clotting. They help fight off infection and assist the immune system with regulating inflammation.

Fat and Brain Development Continued

As it relates to the brain, EFAs are needed for neural development and the maturation of the sensory systems in children, especially males. In fact, omega-3 deficiencies are linked to decreased mental abilities, tingling nerves, poor vision, reduced immune function, and learning

disorders. Studies in fats have shown that diets without omega-3 fatty acids may damage the systems that use the neurotransmitters dopamine and serotonin in the brain's frontal cortex. Although most Americans eat a lot of omega-6 fatty acids, it is not always converted correctly. A diet high in sugar, alcohol, and processed foods diminishes the body's ability to convert omega-6 fatty acids correctly. Omega-6 fatty acids affect neurotransmitter release and contribute to the ability of neurons inside the brain to use glucose for energy. Therefore, if you want to maximize brain function, then eating foods that are high in omega-6 fatty acids, while decreasing the consumption of sugar, alcohol, and processed foods, is important.

Food Sources of EFAs

As previously mentioned, most Americans eat more omega-6 fatty acids than they need. Therefore, we will focus on high omega-3 fatty acid food sources. Oily fish, seeds, and nuts are great sources of omega-3 fatty acids. The omega-3 fatty oils in certain fish—especially salmon, trout, mackerel, herring, sardines, pilchards, and kippers—are great for healthy brain function. They're also important for a healthy heart and joints.

If you aren't a seafood or fish fan, then it's important to know that omega-3 fats can also be found in linseed and flaxseed oil, soya bean oil, pumpkin seeds, and walnuts. Walnuts also have lots of heart-healthy and anti-inflammatory nutrients and help promote blood flow, allowing for more oxygen to be delivered to the brain.

As you can see, fats play a big role in brain health. Not only does fat make up 60% of the brain's dry weight, but an imbalance of fats in the brain can impact the brain's ability to metabolize glucose and impair its ability to use dopamine and serotonin correctly.

Your Body is a Mansion: A Simple Analogy Continued

In the mansion analogy that we've been using for the human body, we've established carbohydrates as electricity because carbohydrates are easily converted to glucose, the body's primary energy source. And like glucose which provides energy to the body, electricity provides energy for the mansion. In the mansion, amino acids which combine to make proteins function as the framework of the mansion. The basic structure of the mansion's frame influences how it will ultimately look and flow.

This makes fat the back-up generator. Wherever electrical energy can be stored in the mansion, there is your analogous fat. That's right, the fat cell is like a biologic battery whose primary role is to store excess energy for later use.

Say the power in the mansion goes out- what are the maids and butlers to do? Luckily, the mansion has a back-up generator that can supply the necessary energy so that the mansion's

maintenance can continue on as normal. In the same way, when the body is low on energy, it knows to turn to the fat cells to utilize the energy that has been stored in them.

Chapter 3: Micronutrients

How Vitamins & Minerals are Used by the
Brain

Vitamins and Minerals: Where They Come From

Although vitamins and minerals are essential for the body, not all of them are manufactured by the body. Therefore, these nutrients need to be obtained through the diet.

Vitamins

There are a total of thirteen vitamins that are required by the human body for growth and maintenance. Each of the thirteen vitamins fall into one of two groups based on their ability to dissolve in water or fat. As the name implies, a fat-soluble vitamin dissolves in fat. Once a fat-soluble vitamin has been absorbed, it is stored indefinitely in the liver and fatty tissues of the body. The fat-soluble vitamins are vitamins D, E, K & A. Fat-soluble vitamins are generally found in the fats and oils of foods.

If fat-soluble vitamins are dissolvable only in fat then we can readily ascertain that water-soluble vitamins dissolve in water. Unlike their fat-soluble counterparts however, water-soluble vitamins are not stored in the body. Excess water-soluble vitamins are excreted through the urine. The water soluble vitamins include vitamin C and a group of eight vitamins known collectively as the B vitamins.

The B Vitamins: B1- Thiamine, B2- Riboflavin, B3- Niacin, B5- Pantothenic Acid, B6- Pyridoxine, B7- Biotin, B9- Folic Acid, and B12- Cobalamin

What do Vitamins Actually Do?

What exactly is a vitamin? According to Merriam-Webster, a vitamin is:

“any of various organic substances that are essential in minute quantities to the nutrition of most animals and some plants, act especially as coenzymes and precursors of coenzymes in the regulation of metabolic processes, but do not provide energy or serve as building units, and are present in natural foodstuffs or sometimes produced within the body.”

Clear as mud, right?

Ultimately, a vitamin is an organic compound that is necessary for helping the body in carrying out a multitude of daily physiological processes.

Vitamins can exist in many forms. Some exist as *provitamins*- a fancy term used to describe the inactive form of a vitamin. A provitamin must be converted into its active form before it can assist with a metabolic process within the cell. Other vitamins function as antioxidants (discussed on page 25 of this chapter) while some operate as coenzymes. A coenzyme must combine with an enzyme (protein) in order to start a chemical reaction within the body.

Vitamins in the Brain

Within the brain, vitamins and minerals are used in the process of transforming amino acids into neurotransmitters and for converting carbohydrates into glucose for fuel. This means that a vitamin or mineral deficiency can affect your mood as well as how your brain functions.

Listed below are the thirteen vitamins used by the body and brain.

Vitamin A

A fat-soluble vitamin, vitamin A is most commonly associated with vision health. In fact, most of us probably remember being told to eat carrots because they would help our eyes grow stronger. Although carrots don't technically contain any vitamin A, they do contain beta carotene which is a precursor to vitamin A. Vitamin A also aids in bone growth, reproduction, cell division, and cell differentiation. Cell differentiation is when a cell becomes part of the brain, muscle, lungs, blood, or other specialized tissue.

Vitamin A, in a sense, helps protect the brain because of the important role it plays in immune system function. If the immune system isn't working at 100%, then the brain and the rest of the body are more susceptible to illness. Foods that are good sources of vitamin A are listed below.

Food Sources: liver, fish, milk, eggs, leafy green vegetables, orange vegetables & yellow vegetables

Vitamin B Complex

Vitamin B complex is a series of eight vitamins that are used in the body to perform a myriad of functions. All B vitamins help the body convert carbohydrates into glucose which is then used for energy. The B vitamins also help the body metabolize fat and protein which are needed for healthy skin, hair, eyes and organs. They also aid in ensuring a healthy and properly functioning nervous system.

B1: Thiamine

Thiamine helps the body with blood formation and circulation. It also maximizes cognitive activity and brain function. In addition, thiamine impacts the energy levels, growth, appetite, and learning ability of the individual. Foods that are good sources of thiamine are listed below.

Food Sources: fortified breakfast cereals, whole grains, rice, pork, trout

B2: Riboflavin

Riboflavin assists with red blood cell creation, antibody production, and growth. It also aids in the metabolism of carbohydrates, fats, and proteins which is important for both the body and the brain. Foods that are good sources of riboflavin are listed below.

Food Sources: fortified breakfast cereals, beef liver, oats, yogurt, milk

B3: Niacin

Niacin helps optimize nervous system functioning and ensures proper circulation of the blood. As it relates to the brain, niacin is beneficial for memory enhancement. Foods that are good sources of niacin are listed below.

Food Sources: liver, chicken, cottage cheese, portabella mushrooms

B5: Pantothenic Acid

B5 is considered the “anti-stress vitamin.” Used for the production of adrenal hormones, formation of antibodies, and conversion of fats, carbohydrates, and proteins into energy, pantothenic acid plays a major role in the body. It also helps produce neurotransmitters in the brain. Foods that are good sources of pantothenic acid are listed below.

Food Sources: liver, sunflower seeds, fish, yogurt, avocado

B6: Pyridoxine

Pyridoxine is involved in multiple bodily functions and affects both mental and physical health. It helps the body absorb fats and proteins and maintains the appropriate sodium and potassium balance. B6 is also crucial for a healthy nervous system, normal brain function, and cellular growth. Foods that are good sources of pyridoxine are listed below.

Food Sources: chickpeas, beef liver, salmon, fortified breakfast cereals, potato

Vitamin B7: Biotin

Your body needs biotin to metabolize carbohydrates, fats and proteins. Available in small amounts in a number of foods, biotin is important for normal embryonic growth, making it especially important during pregnancy. Bacteria in the intestine can also make biotin. Foods that are good sources of biotin are listed below.

Food Sources: fortified breakfast cereal, chocolate, egg yolk, legumes, milk, nuts

Vitamin B9: Folic Acid/Folate

Used in the formation of red blood cells and for the production of energy, folate is very important for the body. As a coenzyme in DNA and RNA synthesis, this vitamin is crucial for cell division and replication. Folate also helps in protein metabolism.

Folate refers to the naturally occurring form of vitamin B9. Folic Acid refers to the synthetic form for vitamin B9. After this section, the terms folate and folic acid will be used interchangeably.

Folic acid is better absorbed by the body than its naturally occurring counterpart, folate. In 1996, the FDA mandated that food manufacturers add folic acid to enriched grain products like rice, bread and cereals, in an effort to decrease the risk of neural tube defects in infants. In doing so, the rates of neural tube defects such as spina bifida and cleft lip/palate has declined. Foods that are good sources of folate are listed below.

Food Sources: liver, spinach, black-eyed peas, fortified breakfast cereals, rice, asparagus

B12: Cyanocobalamin

Vitamin B12 helps folic acid with red blood cell formation. It's also helps the body use iron properly. Needed for the absorption of nutrients and for creating proteins, vitamin B12 also helps with forming cells. Because it maintains the fatty sheaths that cover and protect nerve endings, vitamin B12 also promotes nerve growth and development. It has also been linked to the production of acetylcholine, a neurotransmitter that enables memory and learning. Foods that are good sources of vitamin B12 are listed below.

Food Sources: clams, liver, fortified breakfast cereals, trout, salmon, milk

Vitamin C

Vitamin C is an antioxidant that is utilized by over 300 different functions in the body. It helps with tissue growth and repair. It is also used in the production of anti-stress hormones and can bind with, and eliminate, heavy metals from the body. Vitamin C also protects against abnormal blood clotting and bruising, promotes wound healing, and helps to form collagen. Lastly, vitamin C helps the body absorb more iron. Foods that are good sources of vitamin C are listed below.

Food Sources: Citrus fruits, bell peppers, tomatoes, strawberries, pineapple.

Vitamin D

Vitamin D is recognized as both a vitamin and a hormone. Important for proper growth and development, vitamin D protects the body against muscle weakness and is necessary for normal blood clotting. Vitamin D also helps the body absorb calcium which is needed to build strong bones.

Vitamin D is synthesized in the body when the skin is exposed to the sun's rays. However, with increased use of sunscreen, coupled with the fact that there are regions of the United States that do not get enough sunlight, it is not ideal to rely on sun exposure for vitamin D. Foods that are good sources of vitamin D are listed below.

Food Sources: swordfish, salmon, fortified orange juice, fortified milk & dairy products, eggs

Vitamin E

A fat-soluble vitamin, vitamin E improves circulation, helps repair tissue, promotes healing, and maintains healthy nerves and muscles. Vitamin E is also an antioxidant and works to fight the damage caused by free radicals in the body. Foods that are good sources of vitamin E are listed below.

Food Sources: sunflower seeds, almonds, sunflower oil, hazelnuts, peanut butter

Vitamin K

A fat-soluble vitamin, vitamin K is used for proper blood clotting. It is also crucial for bone formation and repair and is used in converting glucose into glycogen for storage. Foods that are good sources of vitamin K are listed below.

Food Sources: Green leafy vegetables like, broccoli, pine nuts, blueberries, carrot juice

Your Body is a Mansion: A Simple Analogy Continued

As we've already stated, your body is like a mansion. In this mansion, carbohydrates are the electricity, the energy source for the grand house. Proteins are the mansion's framework and fat is the back-up generator/secondary power source. Mansions also have a staff of maids and butlers who constantly work to maintain the property, ensuring that it is clean and operating at optimal capacity. They scurry around turning on lights, vacuuming carpets, mopping floors, opening doors, etc. It is these maids and butlers that are like vitamins.

The maids and butlers do not contribute any electricity towards the mansion in the same manner that a vitamin does not contribute any energy (calories) to the body. But vitamins ensure that the appropriate switches are turned on so that the body can access said energy. You need the maid to plug in the vacuum cleaner and press the power button before the carpet can be cleaned. You need the butler to ensure all of the windows are shut so that the electricity which helps heat the mansion isn't wasted.

The Radicals Are Out to Get Us...the Free Radicals that is...

No, free radicals aren't a political party. They aren't a group of people who believe in freeing all political or religious radicals either.

Simply put, they're atoms. Atoms with an odd number of electrons...meaning that one electron is unpaired.

You're probably wondering what the big deal is with having one unpaired electron. The easiest way to illustrate this danger is to liken an unpaired electron to a gorgeous girl with deep-seeded insecurity issues. Come on, we all know one of those. She's beautiful, everyone tells her she's beautiful, but she can't seem to believe it herself. About the only way she knows how to obtain a sense of self-worth is by constantly being in a relationship.

And when she's not in a relationship, all hell breaks loose.

Electrons, like your gorgeously crazy friend with deep-seeded insecurity issues, like to be paired. They want a fellow electron with whom to share their life. In fact, they need a companion electron just to remain stable. God forbid an electron become unpaired. An unpaired electron is liable to lose its mind, blow up the joint, and take any and all victims with it. In the unpaired electron's mind, if it's unhappy then everyone else has to be unhappy too.

In other words, free radicals are highly reactive. And that's precisely why they're dangerous. They can start a chain reaction of events in your body that damages a cell's membrane, or worse, damages your DNA.

So what births a free radical? The human body generates free radicals as a byproduct of converting food into energy. They can also be formed as a result of exposure to sunlight. Free radicals exist in the food that you eat and in the air that you breathe. In other words, free radicals are all around us.

They're everywhere, man. How do we combat the radical enemy???

Antioxidants.

Sound familiar? It's a term commonly tossed around in the media. You may have heard it mentioned in commercials for supplements, shampoos, sunscreens and lotions. But unless you've actively sought out to understand what an antioxidant is, then you've probably never truly understood why they're so important for your body. They're important because they fight the enemy.

Antioxidants are your friends. They are willing to donate one of their electrons to the free radical without becoming a crazy free radical themselves.

Fruits and vegetables are rich sources of antioxidants. Eating a diet high in these food sources will help the body combat the daily assault inflicted by free radicals.

Minerals

Minerals are used in your body to maintain proper fluid balance, build bone, form blood, and maintain healthy nerves and muscles. Minerals also work as coenzymes that promote energy production, growth, and healing. Minerals work synergistically with each other; therefore, if one is out of balance, the others are affected too.

Minerals that are needed by the body are called essential minerals. Essential minerals can be divided into two groups:

1. Major Minerals – also known as macrominerals
2. Trace Minerals – also known as microminerals

These two groups of minerals are equally important within the body. The amount needed by the body is NOT an indication of their importance or necessity.

Macrominerals

As previously mentioned, macrominerals are those minerals that are required in larger amounts by the body. Although more of these minerals are needed by the body, they are not more important than trace minerals, which will be discussed in the next section.

Calcium

Calcium helps with muscle contraction, including maintaining a regular heartbeat. It's also important for healthy bones and teeth. Used in the formation of RNA and DNA, calcium helps transmit nerve impulses and aids in neuromuscular activity. It's also used in blood clotting, blood pressure regulation, and immune system function. Foods that are good sources of calcium are listed below.

Food Sources: dairy, sardines, fortified orange juice, tofu, kale

Chloride

Chloride is needed by the body for proper fluid balance and is used in stomach acid. Because the American diet is high in salt, which is also known as sodium chloride, then foods that are good sources of chloride are also high sodium food sources. Foods that are good sources of chloride are listed below.

Food Sources: table salt, soy sauce, processed foods, milk, bread.

Phosphorous

Phosphorous is important for healthy bones and teeth. Found in every cell within the body, phosphorous is a part of the system that maintains the acid-base balance of the body. Foods that are good sources of phosphorous are listed below.

Food Sources: meat, fish, poultry, eggs, milk, processed foods

Potassium

Potassium is needed for a healthy nervous system as well as maintaining a regular heart rhythm. Potassium works with sodium to create a healthy water balance in the body. It aids in transmitting electrochemical impulses, helps prevent stroke, and enables muscles to contract efficiently. It also manages the exchange of nutrients through the cell membranes. Foods that are good sources of potassium are listed below.

Food Sources: dried fruit, sweet potato, potato, banana, tomato, spinach

Magnesium

Magnesium is a catalyst for energy production and helps with calcium and potassium uptake. Magnesium also helps prevent depression, dizziness, and muscle twitching. Found in bones, magnesium relaxes tight muscles, helps maintain proper pH balance and immune system health. Foods that are good sources of magnesium are listed below.

Food Sources: almonds, spinach, cashews, peanuts, cereal

Sodium

Sodium is needed by the body for proper fluid balance, nerve signal transmission, and muscle contraction. Although sodium is a macromineral, meaning that it's needed in larger amounts by the body, the majority of Americans don't need to focus on getting more sodium. In fact, most Americans should cut down on their salt intake. The American diet is high in sodium chloride, also known as salt. This is the result of the prevalence of processed foods in American society. Foods that are good sources of sodium are listed below.

Food Sources: table salt, soy sauce, processed foods, milk, bread

Sulfur

Sulfur is found in protein molecules and therefore, is essential for life. This means that sulfur is also important for the brain since it needs protein in order to function properly. About half of the

body's sulfur is concentrated in the muscles, skin, and bones. Foods that are good sources of sulfur are listed below.

Food Sources: meat, poultry, fish, eggs, milk, legumes, nuts

Microminerals

As previously mentioned, microminerals are also known as trace minerals. Trace minerals are those minerals that are needed by the body in small amounts. But just because they are needed in smaller amounts than their macromineral counterparts, it does not mean that they are less important. Trace minerals are just as vital for health as the major minerals.

Chromium

Chromium works closely with insulin to regulate blood sugar (glucose) levels in the body. This is especially important to understand since insulin ultimately impacts how much sugar is going to go into the brain and body. Foods that are good sources of chromium are listed below.

Food Sources: lean meats, liver, whole grains, nuts, cheese

Copper

Copper is part of many enzymes and is found throughout the body. Needed for iron absorption, copper helps the body make red blood cells and keeps both the nerve cells and immune system healthy. The mineral may also act as an antioxidant, fighting free radicals that can damage the body's DNA. Foods that are good sources of copper are listed below.

Food Sources: legumes, nuts, seeds, whole grains, organ meats

Fluoride

Fluoride is involved in the formation of bones and teeth. It also helps to prevent and reduce tooth decay. Most municipal water systems, although not all, provide fluoridated water to their residents. While breastfeeding is the normal way to feed an infant, and provides the best nutrition for the infant, breastmilk has very small amounts of fluoride. For breastfeeding moms who are concerned about whether or not their infants are getting enough fluoride, they should consult an IBCLC (International Board Certified Lactation Consultant). Foods that are good sources of fluoride are listed below.

Food Sources: drinking water, fish, most teas

Iodine

Iodine is needed by the body for proper thyroid function which regulates growth, development, and metabolism. It also helps the muscles, heart, and kidney function well. A fairly new addition to prenatal vitamins, iodine is vital for brain development within the fetus.

Not getting enough iodine can limit a child's growth and brain development. During pregnancy, a lack of iodine can lead to miscarriage, prematurity, and mental retardation. Iodine deficiencies are relatively rare within the United States since most of the salt supply is iodized. Be aware that the salt used in processed foods, however, doesn't usually contain iodine. Foods that are good sources of iodine are listed below.

Food Sources: iodized salt, seafood, bread, milk, cheese, yogurt

Iron

Iron is used in hemoglobin to help carry oxygen throughout the body. Important for growth, a healthy immune system, and energy production, iron plays an important role in the body.

There are two forms of iron:

1. Heme iron
2. Non-heme iron

Heme iron comes from animal sources and includes meats like chicken, fish, and steak. Dairy products like milk and cheese are also examples of heme iron. Non-heme iron refers to iron from plant sources like dark, leafy, green vegetables, legumes, and lentils. To increase iron absorption, high iron foods should be combined with vitamin C. Please note that calcium, and the tannins found in teas, decrease iron absorption in the body. Foods that are good sources of iron are listed below.

Food Sources: chicken, steak, fish, dairy foods, beans, lentils, dark leafy greens, enriched breads and cereals, fortified cereals

Manganese

Manganese is part of many enzymes that metabolize protein and fat. It is also vital for healthy nerves, a healthy immune system, and regulating blood sugar levels. Also used in the formation of cartilage and the synovial fluid in the joints, manganese is an important mineral for the body. Foods that are good sources of manganese are listed below.

Food Sources: nuts, seeds, whole grains, legumes, pineapple

Molybdenum

Molybdenum is part of numerous enzymes that are used throughout the body. The primary function for this mineral is that it acts as a catalyst for enzymes. For example, molybdenum initiates the reaction that uses iron in the body which is very important since iron helps deliver oxygen to the body. Molybdenum also helps the breakdown of certain amino acids in the body. Foods that are good sources of molybdenum are listed below.

Food Sources: legumes, breads, grains, leafy greens, milk, liver

Selenium

Selenium functions as an antioxidant within the body especially when combined with vitamin E. It also plays a role in thyroid function and is needed by the immune system in order to work properly. Foods that are good sources of selenium are listed below.

Food Sources: meats, seafood, grains

Zinc

Zinc is needed for making protein and genetic material. Used in the formation of cartilage, zinc is also used in the production of sperm and is necessary for normal growth and sexual maturation. Zinc is also used in maintaining a healthy immune system and for wound healing. It enhances the sense of taste and smell for the individual as well. An adequate intake and retention of zinc in the body is needed to maintain proper levels of Vitamin E. Foods that are good sources of zinc are listed below.

Food Sources: oysters, beef, crab, yogurt, chickpeas, cheese, milk, vegetables

Water

The human body is two-thirds water. In the same way that the brain being 60% fat lets us know that fat is important for the brain, the fact that the body is 67% water tells us that it's important for us. Water is utilized in every function of the body. It transports nutrients into every cell and transports waste out of every single cell. Water maintains the body's temperature and is needed for all digestive actions, circulatory functions, and nutrient absorption.

The brain is about 80% water (remember, the dry weight of the brain is 60% fat), so it is important to drink lots of fluids for proper brain function. Lack of adequate hydration can affect both mood and concentration. About 2.5 liters of water is lost each day through sweat, breath and urine. In order to replace the water that we've lost, we should drink 1.5 liters of non-alcoholic fluids every day.

Your Body is a Mansion: A Simple Analogy Continued

If your body is the mansion with the carbohydrates functioning as the electric source of energy, protein as the mansion's framework, fat as the back-up generator, and vitamins as the butlers and maids, then minerals are the sturdy material, the mortar and bricks, that strengthen the frame of the mansion.

Minerals help with a variety of functions in the body so that it can stay strong in the same way that the mortar and bricks of the house contribute to a strong foundation. It's not enough to just have the framework of the house. The mortar and bricks must be laid down to build a sturdy mansion. It's the same for the body. Just think of how calcium helps build strong bones or how iron helps transport oxygen throughout the body.

Chapter 4: Putting it All Together

How nutrients interact to support proper brain function

Your Body is a Mansion: Putting it All Together

Once you put all of the pieces together, you have a mansion that protects its inhabitants from outside elements much in the same way that your body works tirelessly to protect you from outside elements.

But not everything from the outside is bad, right?

The electricity for the mansion comes from an outside source in the same way that is created from food that enters the body. And within the mansion, each room serves a different purpose. The purpose and shape of each room is determined by the framework of the house in the same way that a protein's purpose and shape is determined by amino acids. And if the electricity suddenly becomes unavailable to the mansion, then there is the back-up generator that supplies power just like how fat functions as a reserve energy source for the body when energy isn't immediately available.

On the micronutrient level, the maids and butlers are your vitamins that work to clean and maintain the mansion. They flip the switches and start the reactions that the body needs for day-to-day maintenance. This makes the minerals the sturdy materials that help strengthen all of the elements of the mansion, by building stronger walls and strengthening the mansion's foundation.

Yes, your body is one amazing mansion. Be sure to take care of it.

Poor Nutrition Makes a Poor Brain

Poor nutrition makes for a poor brain. Not getting enough nutrition can have dire consequences on the brain. To optimize brain health, focus on a diet that minimizes processed foods and focuses on eating food in its whole, most natural form.

At the end of the day, it's important to incorporate fruits and vegetables into the diet. Not only do they provide energy to the body but they also provide vitamins, minerals, and antioxidants which the body and brain uses for maintenance each and every day. Eating meat and animal products, or high protein plant sources for vegetarians, is also important because both the body and brain need the amino acids from protein to function properly. Just remember that you probably don't need to spend a lot of energy focusing on protein since the American diet is generally high in protein intake. Also be sure to eat healthy fats which can be found in seafood, vegetable oils and nuts because the brain needs these healthy fats in order to function correctly. If you're an advocate of grain consumption, aim for whole grains like whole wheat bread, cereals, and pasta.

By incorporating a wide variety of different foods into the diet, you are helping to ensure that your nutrition is optimized. As a result, you will ultimately help your brain work better.

Chapter 5: Controversial Ingredients

Common ingredients in today's food supply
that have been shown to impact and impair
brain function

No Brain, that's Not Good for You

The first four chapters of this book discussed the macronutrients and micronutrients that the body needs and uses to optimize brain, and overall physiological, function. This chapter is going to discuss controversial ingredients, most of which contain man-made products that could be harming not just your health, but your brain as well.

Alcohol

Alcohol is the first “ingredient” on the controversial ingredients list. Although red wine is often cited as having particularly great heart health benefits, due to the antioxidant properties of the nutrients in it, the risks of drinking alcohol may outweigh the benefits. For one, alcohol consumption damages and kills brain cells. Even if it's consumed in amounts lower than government recommendations, alcohol has been associated with a higher risk for certain cancers.

Among the Western world, alcohol tops the list for ingredients that affect neural function. Not only does it impair your judgement, reflexes, and motor skills, but alcohol consumption during pregnancy can have a profoundly negative impact on fetal development. For these reasons, alcohol starts the list of controversial ingredients because of the known negative effects that it has on cognitive function.

Artificial Food Colors

Artificial food colors are chemical dyes used to color foods and drinks. Food manufacturers may use artificial food colors for a variety of reasons to:

- Offset color loss due to exposure to light, air, temperature extremes, moisture, or storage conditions
- Make natural variations in color look more uniform
- Enhance colors that occur naturally
- Provide color to colorless and “fun” foods, like popsicles

The reason why artificial food colors are controversial is because they've been suspected of causing increased hyperactivity in children. Dye Yellow No. 5 has been suspected of worsening asthma symptoms although the most controlled studies have not been able to prove this. And in the 1970s, the FDA famously banned Red Dye No. 2 after some studies found that large doses actually caused cancer in rats.

According to a 2007 British study published in *The Lancet*, artificial coloring & preservatives did result in increased hyperactivity in kids. However, scientists have been studying the link between hyperactivity in children and food additives for over 30 years with mixed results. Regardless, the study was enough to encourage the European Food Standards Agency to urge companies to voluntarily remove artificial coloring from food products.

Artificial Sweeteners

Artificial sweeteners abound in our society. From the moment an American child is old enough to eat in a restaurant, they are presented with the world of artificial sweeteners. Equal, Splenda, and Sweet 'n Low are probably what comes to mind first when we think about artificial sweeteners. So what's the scoop behind these controversial ingredients?

It was with great caution that the American Heart Association and the American Diabetes Association gave their approval for the use of artificial sweeteners. These fake sweeteners were approved as a means to combat obesity, metabolic syndrome, and diabetes- all of which are risk factors for heart disease. But despite the proliferated use of artificial sweeteners in our society, obesity rates in the United States have continued to steadily climb up.

The FDA has approved five artificial sweeteners for use in the food industry: saccharin, acesulfame, aspartame, neotame, and sucralose. It has also approved one natural low-calorie sweetener, stevia.

One controversy with artificial sweeteners is that they are far more potent than sugar. This means that it takes a far lesser amount of fake sugar to sweeten your tea than it would if you were to use real sugar. As a result, individuals who regularly use artificial sweeteners may find naturally sweet foods, like fruit, less appealing and frankly, may think vegetables are downright appalling.

It's also important to note that in the Multiethnic Study of Atherosclerosis, daily consumption of diet drinks were associated with a 36% greater risk for metabolic syndrome and a 67% increased risk for type 2 diabetes. That's interesting information considering that these are the conditions and disease states that artificial sweeteners were supposed to prevent in the first place. So what does that tell you about the efficacy of fake sugar?

Fake sugar won't solve your problems and it certainly doesn't make your food healthier.

So the next time you have a hankering for a soda, a cookie, candy, or any sugary treat, please eat the full calorie, sugar-laden item. While it will be riddled with simple carbohydrates that will flood the brain all at once with glucose, at least the brain will be bombarded with nutrients derived from real food instead of artificial, lab-created sugars.

Trans-Fats

Trans-fat is perhaps the scariest ingredient in today's food supply. Imagine putting vegetable oil in a beaker. Pummel this beaker with the maximum number of hydrogen atoms possible until the oil becomes solid and you have completed a process known as hydrogenation. Any hydrogenated and partially hydrogenated oil is a trans-fat.

The majority of trans-fats consumed in the US come from processed foods. Originally used because they could extend the shelf life of many baked goods like cookies, cakes, pizza crusts and crackers, trans-fats weren't initially intended for bad. Rather, they were supposed to be good, an invention to revolutionize the food industry of America. However, the problem with trans-fat is that because they aren't naturally occurring in nature, the body doesn't metabolize them. That's right. When your body sees a trans-fat, it doesn't know what to do with it because it has never seen it before. As a result, cells run the risk of being damaged by trans-fats.

The good news is that in the summer of 2015, the FDA gave food manufacturers 3 years to remove trans-fats from all of their products. That's a definite win for the consumer. But be aware that even if a product claims to have zero grams of trans-fat, there could still be trans-fat in the food. This is because labeling laws allow manufacturers to claim "zero grams trans-fat" if there is less than 0.5 grams of trans-fat per serving. This means that your best bet for ensuring trans-fat free food is to read the ingredients label. If you see anything with the word "hydrogenated" or "partially hydrogenated" in the list then it means there's trans-fat present and you should definitely avoid that food.

Tertiary Butylhydroquinone

Tertiary Butylhydroquinone (TBHQ) is a food preservative that functions like an antioxidant. But this antioxidant isn't the same as the healthy antioxidants found in fruits and vegetables. Rather, TBHQ is used as a preservative to extend shelf life and prevent discoloration in foods that contain iron. It also prevents rancidity which is what happens when fat spoils.

This means that TBHQ is used in a plethora of processed foods since nearly all of them contain some amount of fat. TBHQ can be found in foods like crackers, noodles, fast foods, and frozen foods. But you won't just find TBHQ in foods- it's also used in paint, varnishes, and skin care products.

That's scary, right? But you can find comfort in the fact that TBHQ has been determined safe by the Food and Drug Administration when consumed in small amounts. According to the FDA, TBHQ cannot make up more than 0.02% of the oils in a food. But research suggests that Americans are getting far more than this in their diet especially if for those eating a diet high in fat and processed foods.

One study showed that TBHQ increased the incidence of tumors in rats. There are also studies that show TBHQ caused liver enlargement, had neurotoxic impacts, caused convulsions, and caused paralysis in laboratory animals. In humans, cases of vision disturbances have been reported when consuming TBHQ.

rBST

Recombinant Bovine Growth Hormone (rBGH), also called Recombinant Bovine Somatotropin (rBST), is a man-made growth hormone that is marketed to dairy farmers to increase milk production in cows. rBST is different from Bovine Growth Hormone (BGH/BST) which is naturally occurring in cattle. Made in a lab using genetic technology, rBST is not permitted for use in the European Union, Canada, and some other countries. In the United States, it was approved for use in cattle in 1993.

The use of rBST is controversial due to concerns regarding the impact that rBST-containing milk could have on human consumers. In addition, cows that have been given rBST tend to suffer from increased udder infections which results in increased use of antibiotics.

While many people believe the use of rBST is detrimental to human health, the research shows that use of rBST is harmful only to cows. As it pertains to humans, the evidence is inconclusive. Regardless, the demand for this product has gone down. In fact, many large grocery stores no longer carry milk from rBGH treated cows and a USDA study conducted in 2007 found that less than 1 in 5 cows were being injected with the hormone.

High Fructose Corn Syrup

High Fructose Corn Syrup (HFCS) is a highly controversial ingredient that can be found in many foods ranging from ketchup and maple syrup to ranch dressing and soft drinks. There has been tremendous debate regarding whether or not HFCS is contributing to the steep increase in U.S. obesity rates. Regardless, there is not enough scientific evidence to say that this sugar source changes metabolism, increases body fat, or increases appetite.

HFCS is derived from corn starch. When corn starch is broken down into individual glucose molecules, it becomes corn syrup. Next, enzymes are added to the corn syrup to convert some of the glucose molecule into fructose molecules. The reason why HFCS is 'high' in fructose is because it contains more fructose than corn syrup.

While there isn't any definitive evidence to prove that HFCS is metabolized differently in the body, or that it negatively impacts brain function, the debate continues. Regardless, the fact of the matter is that HFCS is a refined sugar that has been so heavily processed that it retains no nutritive value outside of the calories it provides. This means that when it's consumed, it will be quickly digested and absorbed into the body thereby flooding the brain with glucose in a short

period of time. As discussed in the first chapter of this book, this can result in impaired cognitive function.

Chapter 6: The Big Picture

How the food you eat impacts not only your physical health but your mental health as well

As discussed in the previous chapter, there are a number of controversial ingredients that are suspected as contributing to a number of rising health concerns throughout the United States. These health issues range from obesity, heart disease, and diabetes to hyperactivity in children, neurotoxic effects, and convulsions. Despite these suspicions, science has yet to definitively confirm any of these accusations.

Regardless, the foods we eat impact our physiological health and brain health. And let's not forget that they impact our gut health as well.

Probiotics & Brain Health

Probiotics are the bacteria that live in your gut and they can play a big role on the health of your brain.

Over 70% of the body's immune system is housed in the gut. In terms of population, the bacteria inside the gut outnumber the body's cells 10:1. These resident bacteria develop an ecosystem in the gut that is influenced by the environment as soon as we are born. These environmental factors include the microbes that are present when we exit the vaginal canal of our mothers, breastfeeding, formula feeding, and the food that we eat. The balance of bacteria in our gut is also influenced by medications, such as antibiotics. Stress and infection can also impact the composition of our gut bacteria.

Psychobiotics: Probiotic Medicine?

Pioneering research is beginning to examine the relationship of the microbial flora of the gut and how it impacts mental health. Thus comes the term psychobiotics- a live organism that, when ingested in adequate amounts, produces a health benefit in patients suffering from psychiatric illness. There have been animal studies in which behavioral changes resulted from exposure to certain bacterial strains. However, little is known about the therapeutic applications of different strains of bacteria.

Gut Feelings

Growing research is suggesting that the microbes that live in our guts could actually influence our brains. Research is even being conducted that uses MRI scans to examine the brains of volunteers as a means to compare their brain structure to the types of bacteria seen in their gut.

This isn't to say that the microbes in the gut are causing changes in brain structure, or in behavior.

But it is interesting to note that in one experiment, when replacing the gut bacteria of anxious mice with the gut bacteria of fearless mice, the anxious mice became less anxious and more gregarious. It was also found that bold mice became more timid when they received the microbes of anxious mice. Aggressive mice even calmed down when the scientists altered their microbes by changing their diet, feeding them probiotics, or dosing them with antibiotics.

How the Gut Microbiome Talks to the Brain

Scientists currently suspect that the vagus nerve functions as a highway of communication between what's going on in the gut and what's going on in the brain. In one experiment, when scientists cut the vagus nerve in mice, they no longer saw the brain respond to changes in the gut. Scientists also suspect that gut microbes may communicate with the brain in other ways such as modulating the immune system or by producing their own versions of neurotransmitters.

Such research increases the potential for scientists to one day create drugs that mimic the signals that are sent from the gut to the brain, or simply give people good bacteria as a means to prevent and treat problems involving the brain.

Feeding the Gut Microbiome

Although the research is still relatively new in terms of whether or not the gut microbiome has an impact on brain health, we do know that the gut microbiome can have a tremendous impact on overall health. That is why it's important to feed your probiotics (gut bacteria) prebiotics- that is, fiber compounds that pass undigested through the upper part of the gastrointestinal tract and stimulate the growth or activity of the good bacteria that colonize the large bowel. Believe it or not, there are good bacteria and bad bacteria that inhabit the gut. The good bacteria are those which are advantageous for our bodies while the bad bacteria either serve no purpose in the body or actually cause harm to the body.

If you're looking to promote and improve the health of your gut microbiome then incorporating fermented foods, such as yogurt, kimchi, and sauerkraut are a good start. Beverages, like kombucha, can also be consumed although pregnant women should not drink it.

Chapter 7: Nutritional Concepts

Concepts that best ensure success towards
optimized nutrition and brain health

Nutritional Concepts

As you've learned in this book, nutrition isn't cut and dry. The science of nutrition is ever evolving as we learn more and more about the human body and the brain. But there are some concepts that should be adhered to in the ever changing world of nutrition. In following these concepts, you will be best equipped to optimize your nutritional health for improved brain function.

Concept #1: Respect the Individual

Nutrition is individual. There is no cookie cutter approach. What may work for one person may not work for another. For some people, they have to avoid foods that contain gluten, a protein that is found in wheat. For others, they can eat gluten and experience no negative impact on their health. Always understand that when working towards better nutrition, your nutritional needs and restrictions should be considered and will be unique to you. Do not compare yourself to others and realize that what may have worked for a friend may not work for you.

Concept #2: Respect the Culture

Nutrition must respect culture. For some cultures, dairy is commonplace while in others, dairy is rare, if not entirely absent. When working to ensure optimal nutrition, consider the staple foods and dishes of your culture and adapt the nutrition accordingly. Do not force yourself to eat a food that you find completely abhorrent just because it seems healthy. That's not to say that you shouldn't try new foods. Just understand that there are dishes in every culture that are healthy and there are always ways to recreate dishes to make them healthier. You don't have to abandon your culture's dietary practices in order to optimize nutrition.

Concept #3: Respect the Lifestyle

Nutrition must respect lifestyle factors. We all live different lives with different schedules and varying incomes. While eating only organic may work for some, it may not work for others. If you perform shift work and don't have a regular work schedule, then you may not be able to immediately cut out all processed foods from your diet. For you, a less harmful version of a processed food may need to be sought out. By respecting and considering lifestyle factors, then success is better guaranteed. When working towards improved nutrition, understand that progress is ongoing and that change won't happen overnight. Understand your lifestyle and make small, but consistent, changes over time.

Concept #4: Respect the Philosophy

Nutrition should never judge. We live in a society of many dietary philosophies and often times the followers of these dietary philosophies hurl stones at each other. Like in religion and politics, we believe that we are correct and everyone else is very, very wrong. In doing this, we perform a

disservice to society because instead of creating a clearer pathway towards better nutrition, we create confusion and discord. When working towards optimized nutrition for improved health outcomes, commit to a diet that adheres to your beliefs without judging the choices of others. In doing so, a relationship of mutual understanding and trust can and will be created.

Glossary

Amino Acid – also known as the building blocks of life, amino acids are molecules that combine to form proteins.

Antioxidant – a nutrient that helps prevent damage that occurs in the body as a result of free radicals.

Artificial Sweetener – substances used to replace sugar in foods in beverages. They can be divided into two large groups: nutritive sweetener which add some calories to food, and nonnutritive sweeteners, which add no calories to food.

Carbohydrate – one of the three macronutrients needed by the body and include sugars, starches, and fiber.

Catalyst – a nutrient that starts a chemical reaction in the body.

Coenzyme – a non-protein compound that is necessary for the functioning of an enzyme.

Essential Nutrient – any nutrient that is needed by the body but cannot be produced by the body and therefore, must be obtained through the diet, i.e. essential vitamin, essential mineral, etc.

Enzyme – a protein that acts as a catalyst to start and help complex reactions occur throughout the body.

Fat – one of the three macronutrients needed by the body; in this book, fat is also referred to as lipids and fatty acids.

Free Radical – a highly reactive molecule with an odd/uneven number of electrons that damages the body's DNA.

Glucose – a simple sugar that is the sole fuel source for the brain and blood cells of the body.

Gut Microbiome – the collection of bacteria, fungi, viruses, etc. that live inside the gastrointestinal tract.

Prebiotic – a non-digestible food ingredient, such as fiber, that promotes the growth of beneficial microorganisms in the intestines.

Probiotic – live bacteria and yeast that are good for your body, especially as it relates to your gastrointestinal tract. Probiotics are found naturally in the body but can also be found in some foods and in supplemental form as well.

Protein – one of the three macronutrients needed by the body; amino acids combine to form proteins.

Macronutrient – a substance needed in large amounts for the normal growth and development of living organisms.

Micronutrient – a chemical element or substance needed in small amounts for the normal growth and development of living organisms.

Mineral – substances found in food that are essential for growth and overall health but are considered inorganic because they do not contain the element carbon.

Non-essential Nutrient – any nutrient that can be created by the body and therefore, does not need to be obtained through the diet.

Recombinant Bovine Somatotropin Hormone – a hormone that is administered to cattle as a means to increase milk production.

Trans-fat – manufactured fats that are created through a process called hydrogenation which aims to stabilize polyunsaturated oils to prevent them from becoming rancid and to keep them solid at room temperature.

Vitamin – a nutrient found in food that is necessary for growth and proper body function. Vitamins are considered organic compounds because they contain element carbon.

References

American Psychological Association. <http://www.apa.org/monitor/mar00/brainbox3.aspx>. Sunday, March 13th, 2016.

Brainline. Nourish Your Noggin: Nutrition and Your Brain. http://www.brainline.org/content/2012/06/nourish-your-noggin-nutrition-and-your-brain_pageall.html. Sunday, March 13th, 2016.

Brain and Spine Foundation. Brain Food: Nutrition Tips for a Healthy Brain. <http://www.brainandspine.org.uk/brain-food-nutrition-tips-healthy-brain>. Sunday, March 13th, 2016.

Brain Guide. <http://www.brain-guide.org/nutrition.html>. Sunday, March 13th, 2016.

David Perlmutter, MD. How Can Probiotics Help Improve My Brain Health? <http://www.drperlmutter.com/can-probiotics-help-improve-brain-health/>. Monday, March 21st, 2016.

Kelly Brogan, MD. Probiotics for the Brain. <http://kellybroganmd.com/probiotics-brain/>. Monday, March 21st, 2016.

Minerals, Their Functions and Sources- Topic Overview. <http://www.webmd.com/vitamins-and-supplements/tc/minerals-their-functions-and-sources-topic-overview>. Tuesday, April 6th, 2016.

National Public Radio. Gut Bacteria Might Guide the Workings of Our Minds. <http://www.npr.org/sections/health-shots/2013/11/18/244526773/gut-bacteria-might-guide-the-workings-of-our-minds>. Monday, March 21st, 2016.

Nutrition and the Brain. <https://faculty.washington.edu/chudler/nutr.html>. Tuesday, March 1st, 2016.

University of California Los Angeles. Changing Gut Bacteria Through Diet Affects Brain Function, UCLA Study Shows.

<http://newsroom.ucla.edu/releases/changing-gut-bacteria-through-245617>. Monday, March 21st, 2016.

University of Maryland. Vitamin H.

<http://umm.edu/health/medical/altmed/supplement/vitamin-h-biotin>. Tuesday, March 15th, 2016.

Western Governors University.

<http://www.wgu.edu/blogpost/brain-fuel-5-food-groups-successful-students>. Sunday, March 13th, 2016.