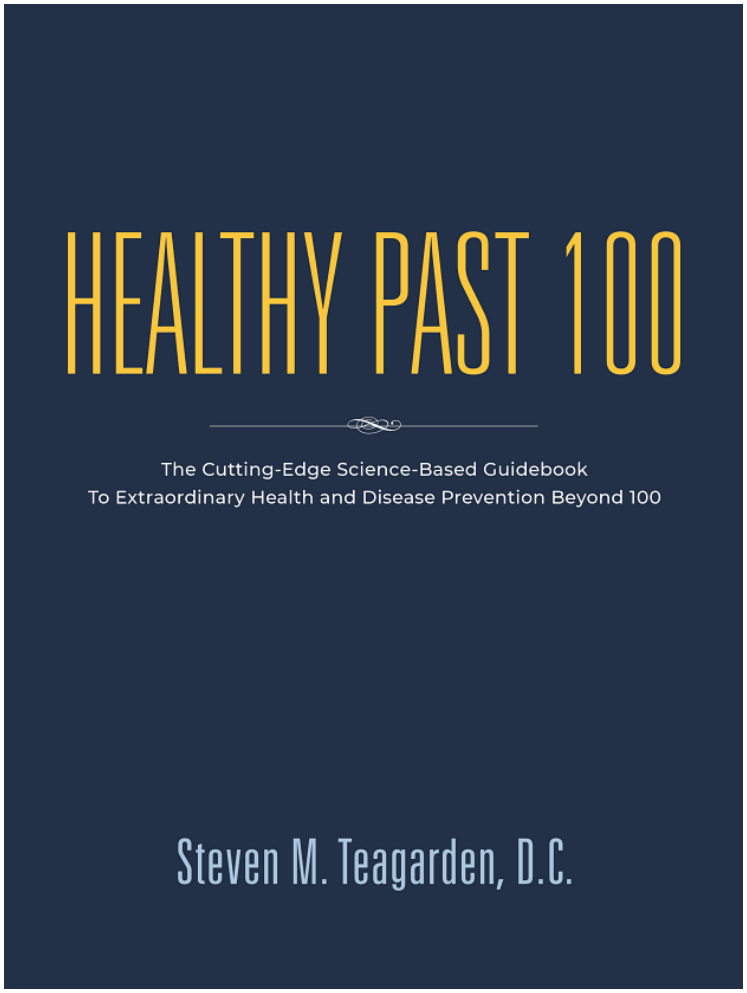

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Healthy Past 100: The Cutting-Edge Science-Based Guidebook to Extraordinary Health and Disease Prevention Beyond 100

By Steven M. Teagarden, DC

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Contents

Healthy Past 100

Introduction

To Be Extraordinarily Healthy, *Do Only What Works!*

If you long to be extraordinarily healthy past your 100th birthday, this revolutionary book is for you. *Healthy Past 100* cuts to the chase and teaches you to focus exclusively on what's been scientifically proven to take your life and health to unprecedented levels—today, tomorrow and for decades to come. Doing only what's been scientifically proven to optimize health saves enormous time, money and frustration. But even more importantly, it may save the most precious commodity of all: your life.

Becoming an exceptionally healthy *centenarian* won't happen by chance. Humans have searched for the mythical Fountain of Youth for time immemorial, but no one has found it. The reason is simple: the Fountain of Youth won't be found by searching outside yourself, because it's already inside you. The Fountain of Youth is an unspeakably powerful healing force, and *Healthy Past 100* helps you tap into it. Extraordinary health isn't a mystery, and anyone can attain it. How do you experience extraordinary health? By doing only what works and leaving the rest behind.

There is a fountain inside you
Don't walk around with an empty bucket.
—Rumi

Doing Only What Works Adds Healthy, Vibrant Years to Your Life

When you learn to make only the healthiest healthcare choices, *you'll add healthy, vibrant years to your life*. By doing only what works, you'll become healthier than ever and maintain remarkable health for years to come. Experiencing extraordinary health past your 100th birthday isn't a pipe dream. It's a reality that's within reach, but only when you do what works. It's important to note that doing only what works means *doing everything that works*. Many believe that megadoses of vitamin C, occasional exercise and positive affirmations are the ticket to optimal health and longevity, but that type of thinking *is* a pipe dream. When you learn to do everything that works, you'll fill your life with the fountain that's inside you. Don't go through life with an empty bucket. Instead, take Rumi's advice and let the fountain within fill your bucket with extraordinary health.

More Energy and Vitality, Less Worry and Concern

As you become healthier than ever, you'll experience greater physical energy and mental clarity. You'll get sick less often and have far fewer aches and pains. You'll bounce back from stressful days and late nights with greater ease, and you'll recover from exercise—even strenuous exercise—more quickly and easily. When you begin to experience extraordinary health, you'll be astounded by how good you feel and wonder how you made it through the day before.

Doing Only What Works Decreases the Risk of Cancer and Heart Disease

Astonishingly, you can greatly reduce the risk of developing ***chronic diseases*** like cancer, heart disease, stroke and diabetes. This point is so important that it bears repeating: when you do only what works, you'll naturally lower your risk of cancer, heart attack, stroke, and diseases like Parkinson's and Alzheimer's. That's the power of doing only what works. This is no exaggeration, and *Healthy Past 100 (HP100)* shows you how. We'll return to this crucial point again and again throughout this book.

To Do Only What Works, Focus on the *Short List*

The ***Short List*** is a distillation of the core factors that must be addressed to become a hearty, healthy ***centenarian***, i.e., one who lives to 100 years. (Bolded and italicized terms appear in the glossary.) By focusing on the Short List, you'll make lasting progress in healing your body and mind. Nearly everyone's *body* requires healing, and so does nearly everyone's *mind*. Just as the body can become sick, tired and toxic, so too can the mind become mired down

with toxic beliefs and habits that zap your energy, dull your creativity and keep you from living in a state of connection and peace. To experience extraordinary health and well-being, you must address your life's physical, psychological and spiritual aspects.

The Short List

It's okay if you're unfamiliar with some or even many of the items in the Short List. Think of it like this: the more items you're unfamiliar with or currently not addressing, the greater your capacity to dramatically improve your health. The Short List is summarized in Table 1, and each item is reviewed in detail throughout this book. The amount of cutting-edge information this book contains—information you can begin applying today to radically reshape your life—is astounding. And while this *HP100* contains a lot of information, 100% of it focuses on what you need to know to address the components of the Short List.

Table 1: The Short List

Core Factor	What It Is and Why It's Important
Diet	The Metabolic Masterplan Diet (MMD) is a highly specialized ketogenic diet that's carefully designed to heal and optimize your metabolism. The MMD also heals your gut, minimizes chronic inflammation and reduces oxidative stress. The MMD is based exclusively on the *Core Essentials*, i.e., the healthiest proteins, fats and fibers you can consume. The Core Essentials are reviewed in detail in the Core Essentials Section, and the Metabolic Masterplan Cookbook is a complete cookbook based on the Core Essentials. The MMD is a vitally important component of the Short List.
Nutrition and Supplements	Providing your cells with the nutrients they require *on a daily basis* is an essential component of the Short List. Nutrient deficiencies cause all aspects of your health to decline, opening the door to sickness and disease. To keep this door tightly shut and make it possible to be healthy past 100, you must provide your cells with the nutrients they require every day. Nutrition and supplementation are reviewed in detail in the Supplements, Vitamins, Minerals, Essential Micronutrients and Digestive Aids Section.
Metabolism	Metabolism is the creation of metabolic energy (ATP) within your cells. The capacity to create energy is synonymous with biological life. When your metabolism becomes damaged, your cells can't make the energy they require, and every aspect of your life and health suffers. As metabolic efficiency decreases, your cells become less capable of utilizing fats and ketones as a fuel source; thus, they become increasingly reliant on blood sugar as their only means of producing energy. The inability to efficiently metabolize fats and ketones is a hazardous, common and pressing healthcare concern in the modern world. If your cells can't burn fats and ketones, *it becomes very difficult to lose weight*. Metabolic damage is characterized by increased fat stores (especially within the abdomen), difficulty losing weight, and the dysregulation of blood sugar, insulin, cholesterol, triglycerides, counterregulatory hormones and adipokines (adiponectin and leptin). This is referred to as *metabolic mayhem*. In addition, metabolic mayhem contributes to chronic inflammation and oxidative stress. Unlike other ketogenic diets, the MMD significantly focuses on healing your metabolism *before* increasing fat consumption. Consuming fat before healing your metabolism is dangerous and can lead to disastrous consequences. Metabolism is reviewed in detail in the Metabolism Section.
Chronic Inflammation	Chronic inflammation is a common healthcare issue in which excess proinflammatory fats and too few anti-inflammatory fats become woven into your cell membranes, brain and other fatty tissues. As a result, chronic inflammation leads to the overproduction of proinflammatory chemicals in your body. These imbalances open the door to all healthcare issues, and must be reversed to decrease the risk of all diseases, eliminate aches and pains and live in optimal health. Therefore, healing chronic inflammation is an essential item on the Short List, and is reviewed in detail in the Chronic Inflammation Section.

Core Factor	What It Is and Why It's Important
Gut Health	The gut is the intersection of the immune system, the digestive system, the nervous system, the endocrine system, many metabolic processes, vast numbers of microbes, your genetic expression, the passing on of heritable traits and your psychology. Everything you think, say, do, feel, eat and drink affects your gut, and your gut affects every aspect of your life and health. Nearly all humans experience impaired gut health, and this condition must be addressed for you to remain vitally alive past your 100th birthday. Gut health is reviewed in detail in The Art of Healing and Optimizing Your Gut Section.
Psychology	Psychology is the sum total of your mental, emotional, cognitive, behavioral and social characteristics. Sometimes referred to as *mind*, psychology describes how we think, feel, act, behave and respond in different situations. Psychology is strongly influenced by factors such as stress, sleep, your current level of health, illness, sickness, disease, environmental factors (temperature and sunlight), diet, nutrition, exercise, thyroid physiology, toxicity, childhood experiences and socioeconomic status. Therefore, optimizing your psychology is a crucial component of the Short List, and is reviewed throughout this book.
Thyroid Physiology	Thyroid physiology is the complex process of delivering thyroid hormones to every cell in your body. Billions of humans suffer from hypothyroidism, a condition in which too few active thyroid hormones are transported to the cells. Inefficient thyroid physiology impairs your body and mind, zaps your energy levels and is associated with many diseases. Optimizing thyroid physiology is a vital component of the Short List, and is reviewed in detail in the Thyroid Physiology Section.
Exercise	Exercise is intentionally moving and straining your body to render it stronger and fitter. Regular exercise improves all health outcomes, including metabolic biomarkers and blood sugar. Unfortunately, many humans don't get nearly enough exercise, which opens the door to every disease on the planet. Therefore, getting plenty of exercise is critical to the Short List. Exercise is reviewed in detail in the Exercise Section.
Detoxification	Detoxification is the process of removing heavy metal toxins from your body. Heavy metal toxins have no known health benefits and are associated with various health issues and diseases. Common sources of heavy metal toxins include smoking, occupational exposure, tap water and diet. Therefore, detoxification is an important component of the Short List, and is reviewed in detail in the Detoxification Section.
Oxidative Stress	Oxidative stress is caused by excess free radicals and a lack of antioxidants anywhere in the body. Free radicals are chemicals produced throughout the body with negative electric charges, and antioxidants neutralize them. Free radicals are technically referred to as reactive oxygen and nitrogen species (RONS). The excess production of RONS causes oxidative stress, which in turn causes catastrophic health issues. The oxidative stress caused by RONS is theorized to be a primary cause of aging, sickness, disease and death. Therefore, minimizing oxidative stress is a major focus of the Short List.
Spiritual/Religious Life	Regardless of the trials and tribulations that everyone faces during their incarnation, we're all something unspeakably greater than our bodies and minds. What you truly are is beyond anything that words can describe. Miraculous health stems from optimal physical, psychological and spiritual well-being. Therefore, devoting energy to your spiritual or religious life is every bit as important as healing your metabolism and switching to the Metabolic Masterplan Diet.

Proof That the Short List Optimizes Your Health: Biomarkers

The Short List is the core factors you must address to take your life and health to unprecedented levels for years to come. When you focus on the Short List, extraordinary shifts occur in your body and mind. Some shifts can be measured, and others can only be experienced. The measurable effects produced by focusing on the Short List are things like blood sugar, A1c, cholesterol levels, triglycerides and body weight; these are known as ***biomarkers***. So how can you be wholly certain that the steps you're taking to improve your health are working? *Measure your biomarkers*.

Don't Play Guessing Games With Your Health. Know. Become Empowered

Don't play guessing games with your health. Don't guess, *know*. How do you stop guessing and know? *Measure your biomarkers*. Biomarkers don't lie. If you want to know if your diet is working, measure biomarkers. If you want to know if your metabolism is healing, measure biomarkers. If you want to know if chronic inflammation is healing, measure biomarkers. To assess your cardiovascular disease risk, measure biomarkers. To assess your thyroid physiology, measure biomarkers. To determine if your autoimmune issues are healing, check biomarkers. How do you know if you're getting enough exercise? Check your biomarkers.

One of the many reasons I have so much confidence in the *HP100* is due to the dramatic improvements I commonly observe in patients' biomarkers. Time after time, I've seen biomarkers go from abysmal to optimal when patients focus their energy on the Short List. When you devote energy to optimizing the Short List, your biomarkers will show dramatic, lasting improvement, and you'll feel this difference in your life.

HP100 helps you dramatically improve your biomarkers. Importantly, it also explains what they are, the most important ones to measure, and how to interpret them in plenty of detail. *HP100* isn't like other books. Its purpose is to provide you with *everything* you need to make empowered healthcare decisions, including how to interpret your biomarkers. When you know which biomarkers to measure and how to decipher them, the guessing games, doubt, worry and concern about your healthcare choices is replaced by confidence, certainty and peace of mind. Biomarkers are comprehensively reviewed in the Metabolism, Thyroid Physiology and Autoimmune Sections.

Table 2: Biomarkers That Are Commonly Improved by the Short List

Body weight	The cholesterol ratio	Oxidized LDL
Body fat percentage	Triglyceride/HDL ratio	Lp(a)
Body fat distribution	Triglycerides	The omega 3:6 ratio
Ectopic fat (NAFLD)	HDL, LDL, VLDL particle size	Blood pressure
Blood sugar	LDL-P (the number of LDL particles)	Thyroid biomarkers (numerous)
Hemoglobin A1c	HDL-P (the number of HDL particles)	Adiponectin
Insulin	VLDL-P (the number of VLDL particles)	Leptin
Cholesterol (HDL, LDL, VLDL)	The apoB/apoA-I ratio	Autoimmune markers (numerous)
Lp-PLA2	Homocysteine	Resting heart rate

The Scientifically Proven Benefits of Lifestyle Interventions

Focusing your attention on the Short List significantly improves biomarkers, but that's just the tip of the iceberg. When you focus on the Short List, you perform what science refers to as ***lifestyle interventions***. Lifestyle interventions occur when you simultaneously improve your diet, exercise regularly, *and* funnel energy into improving at least one "other area" of your life. *Other areas* include reducing stress levels, counseling, or quitting smoking[1].

When you materially improve several aspects of your life *at the same time*, an effect akin to "the whole is greater than the sum of its parts" emerges from deep within you and permeates the entirety of your being. Lifestyle interventions allow possibilities to become manifest that cannot happen through any other means. The fact is that by focusing on the Short List—by making lifestyle interventions—it's possible to powerfully reshape your life, health and future in ways that defy logic and stretch the bounds of reason. That's why this book was written.

The Meeting Place of Miracles and Science

When you wholeheartedly focus on the Short List and make lifestyle interventions, miraculous health becomes infinitely more available. Scientists, however, don't use phrases like *miraculous health*. Instead, they use terms like *chronic diseases, longevity, lifespan, healthspan, healthy aging, all-cause mortality* and *quality of life* to assess health. In this book, we'll use spiritual terms like miraculous health, and we'll also use scientific terms like chronic diseases and all-cause mortality. A wide range of terms is necessary to address the multifaceted nature of human life. Please take a few minutes to familiarize yourself with the following scientific terms, because they're used throughout this book.

The Scientifically Proven Benefits of Lifestyle Interventions:

- Significantly reduced odds of developing ***chronic diseases***, e.g., cancer, stroke, diabetes and Alzheimer's disease
- Increased ***longevity***, i.e., living longer than the people in your country of the same gender and race
- Increased ***lifespan***, i.e., the span of time between birth and death
- Increased ***healthspan***, i.e., the span of time prior to developing chronic diseases like cancer and heart disease
- Increased ***healthy aging***, i.e., the continuance of a high degree of function and wellness into advanced age
- Decreased ***all-cause mortality***, i.e., the diminished risk of death from any and all causes
- Increased ***quality of life (QOL)***, i.e., a sense of deep satisfaction with your day-to-day life
- Decreased ***risk factors***, i.e., the controllable factors that contribute to poor health and disease

Chronic Diseases

According to the Centers for Disease Control and Prevention (CDC), the World Health Organization (WHO) and a large body of scientific evidence, the incidence of ***chronic diseases*** such as cancer, cardiovascular disease and diabetes can be substantially reduced when you make lifestyle interventions. Astounding but true, 90% of diabetes, 80% of cardiovascular disease, 70% of strokes and 70% of many cancers *are preventable* by making *in-time* diet and lifestyle interventions (implementing changes *before* chronic diseases develop)[2,3,4]. Cancer, in particular, is a terrifying and misunderstood disease, but most people can markedly reduce their cancer risk by learning how to make lifestyle interventions. This earth-shattering revelation is summed up with the following quote from a 2008 science article published in the journal *Pharmaceutical Research:*

> Only 5–10% of all cancer cases can be attributed to genetic defects, whereas the remaining 90–95% have their roots in the environment and lifestyle[5].

Chronic Diseases Aren't Genetic. They're Caused by Poor Lifestyle Choices

This information is a radical departure from what we've been led to believe about chronic diseases such as cancer. Mainstream medicine has long reinforced the idea that chronic diseases are caused by faulty genetics. However, the real story is that chronic diseases—including cancer and cardiovascular disease, which kill more people than other diseases—have more to do with poor *lifestyle choices* than faulty genetics. The term "lifestyle choices" includes *all* the choices that add or subtract from your health; *healthy* lifestyle choices are synonymous with the Short List. The Fountain of Youth is a powerful force inside you, and lifestyle interventions are what set it free.

Focus on Epigenetics, Not Genetics

Genes are like tiny switches inside our cells and have a powerful effect on all aspects of our lives and health, including the development of diseases like cancer. When we're unhealthy, undernourished, out of shape, stressed out, afraid, depressed, anxious, obese, tired, overworked, hypothyroid, toxic and so forth, our genetic "switches" (genes) flip in an *unhealthy* direction. When we're healthy, well-rested, in shape, adequately nourished, open, connected, peaceful, compassionate, genuine, giving, loving, forgiving, accepting and optimistic, our genetic switches are far more likely to flip in a *healthy* direction.

The factors that cause our genes to shift in a healthy or unhealthy direction are ***epigenetic influences***[6]. When our genetic switches flip in an unhealthy direction, the door to health issues and diseases swings open. The opposite is also true: when our genetic switches flip in a healthy direction, the door to health issues and diseases remains tightly shut more of the time. It's not so much what's going on with our genes per se; it's what's pushing and pulling on them that matters. Genes matter, but the reason they matter has far more to do with the epigenetic influences in your life, not the genes themselves.

You can't change genes, but you can change the numerous positive and negative epigenetic influences that push and pull on them. Therefore, focusing on the Short List can essentially be boiled down to addressing the multiple positive and negative epigenetic influences that impact your life and health. Genetics and especially epigenetic influences are reviewed in detail in The Art of Healing and Optimizing Your Gut Section.

Chronic Diseases Provide Few (If Any) Warning Signs

Once chronic diseases develop, the prevailing wisdom is that they can't be cured by medications or other means. They usually last until the time of death, they don't spontaneously disappear, and they often *produce no symptoms until the disease becomes advanced*. The sobering truth is that many chronic diseases provide *few or no warning signs*. In a cruel twist of fate, you can feel fine one day and be reeling from the effects of a heart attack, stroke or terminal cancer diagnosis the next, all without any idea that your health was progressively worsening.

Nearly half of American adults (approximately 45%, or 133 million) suffer from at least one chronic disease, and this number continues to rise[7,8,9]. Over 25% of American adults have two or more chronic conditions, and half of older Americans have three or more chronic diseases[10]. The most common chronic diseases include cardiovascular disease, stroke, cancer, diabetes, arthritis, hypertension, respiratory and oral diseases. In the US alone, chronic

diseases account for approximately 75% of aggregate healthcare spending, or an average of $5,300 per person annually. Children suffer from chronic diseases as well. In the US, the incidence rate of chronic diseases in children went from 12.8% in 1994 to 26.6% in 2006. The incidence rates of chronic diseases for children and adults are expected to do nothing but climb[11].

More Than Two-Thirds of All Deaths Are Caused by These Chronic Diseases:

- Heart disease
- Cancer
- Stroke
- Chronic obstructive pulmonary disease (COPD)
- Diabetes

Lifespan, Longevity, Healthy Aging and Healthspan

Lifespan and Longevity

Humans in rapidly industrializing nations began living longer around 1840. This trend continues today, with the US being a notable exception, where the average ***lifespan*** (the time between birth and death) is declining[12]. (This is a very, very ominous sign for the health of Americans.) The average lifespan varies from country to country, and is an important measure of a nation's health. Whereas lifespan is the time between birth and death, the term ***longevity*** is defined as *the capacity to live longer than the average lifespan of the people of your country*[13]. For example, if the lifespan of Caucasian males in Canada is 78.4 years, *longevity* occurs when a Canadian Caucasian male lives longer than this age.

Healthy Aging

To be meaningful terms, lifespan and longevity must also include the ability to function at a high level *well into advanced age*. After all, what's the point of living longer if you're in physical and cognitive decline? To address this point, the World Health Organization (WHO) uses the term ***healthy aging***, which is "the continuance of a high degree of function and wellness into older age[14]." The Pan American Health Organization defines healthy aging as "a continuous process of optimizing opportunities to maintain and improve physical and mental health, independence, and quality of life throughout life."

While lifespan and longevity have increased worldwide, *healthy aging hasn't*. In other words, humans live longer than ever before, but they don't experience a high level of health as they age. In fact, many humans spend the last 1-2 decades of their lives in declining and even poor health. Of course, how long you live matters, but how well you live is what really matters. Thus healthy aging is a crucial health assessment tool.

Healthspan

The term ***healthspan*** differs from lifespan, longevity and healthy aging, and provides unique insight into what it means to be healthy. Unlike lifespan, which is the total amount of time an organism lives, healthspan is the time you can expect to live *before developing chronic diseases like cancer and heart disease*[15]. For example, the healthspan for Americans is currently 66 years, meaning the average American is diagnosed with a chronic disease at this age. However, Americans live for an average of 79 years, meaning that the last 13 years of the typical American's life is spent dealing with chronic diseases like cancer and heart disease. Thus healthspan is significantly shorter than lifespan for most humans.

Chronic Diseases Are So Common That They're Predictable

Healthspan reveals a chilling reality: chronic diseases like cancer are so common that scientists can predict the average age at which they develop. Once chronic diseases appear, healthspan gives way to declining health, sickness, disease, diminished quality of life and a lack of healthy aging. This need not be! By making lifestyle interventions, you can increase your healthspan, i.e., live longer without developing chronic diseases like cancer. Lifestyle interventions also increase lifespan, longevity and quality of life. That's the incredible power of focusing on the Short List, making lifestyle interventions, and doing only what works.

All-Cause Mortality

It's widely accepted that making informed healthcare choices increases lifespan, healthy aging and healthspan[16]. This makes sense, just as it makes sense that poor healthcare choices decrease your overall health and well-being. But that's not all that poor healthcare choices do: poor healthcare choices increase the risk of ***all-cause mortality***. All-cause mortality is just what it sounds like: the risk of death from any and all causes.

Epidemiologists and others who study lifespan, healthy aging and healthspan are keenly aware of the factors contributing to all-cause mortality and early death. These factors include smoking, alcohol consumption, obesity, lack of exercise, stress and poor dietary habits[17, 18, 19, 20, 21]. The risk of all-cause mortality is also increased by psychological factors, including loneliness[22], stress[23], distress[24], limited social network[25,26], lack of leisure time[27], stress-related disorders, e.g., PTSD[28], depression[29] and social isolation[30]. Although generally given less significance than factors such as diet and exercise, psychological factors are every bit as impactful on health and all-

cause mortality as physical ones[31]. Optimizing your health requires healing your body, but it also requires healing your mind.

Risk Factors for Chronic Diseases

When you make lifestyle interventions, you positively affect what science refers to as ***risk factors for chronic diseases***. Risk factors for chronic diseases (abbreviated as risk factors) are just what they sound like: they're the factors that increase the risk of developing chronic diseases.

Some risk factors can be modified and others can't. The risk factors that can be modified are referred to as *modifiable risk factors*. The risk factors we can't modify or change include age, gender, race and blood type[32]. These are *non-modifiable risk factors*. Modifiable risk factors include poor dietary choices, physical inactivity, smoking, air pollution and environmental toxins, alcohol consumption, depression, obesity, high blood pressure, elevated blood sugar, and cholesterol and triglyceride imbalances[33,34,35,36].

When you focus your attention on the Short List, you positively influence several modifiable risk factors at the same time, which greatly reduces your risk of developing chronic diseases like cancer, stroke and Alzheimer's disease[37]. This is referred to as *optimizing modifiable risk factors*, and is synonymous with making lifestyle interventions. An essential point about optimizing modifiable risk factors, lifestyle interventions and the Short List—they're all the same—is that they increase your longevity, lifespan, healthspan, healthy aging and quality of life. They make you healthier, allow you to live longer, *and* decrease the risk of all-cause mortality and chronic diseases. That's the incredible power of focusing on the Short List, and it explains why doing so leads to miraculous health.

What Is Health?

For all the focus we place on our health, it's curious that almost no one can say what it is. I've asked the question "*what is health?"* hundreds of times, and nearly everyone finds it hard to put it into words. Medicine, governments and the world per se have historically defined health as a state free from symptoms and disease, but reducing one of the most important measures of life to the absence of symptoms and disease is to miss the point of life in every respect—and speaks volumes about how we approach the precious commodity known as health.

When this life ends and we cross into another dimension, our cosmic greeting committee isn't going to evaluate how well we lived based on our avoidance of symptoms and disease. Our guardian angels aren't going to come down hard on us for having had the sniffles as children, nor will they shame us for having had cancer or a heart attack later in life. This is because health is so much more than the absence of symptoms and disease; it's imperative to expand our ideas about what it is while we can take action to optimize it.

What is health? It's the capacity to fully participate in and enjoy what truly matters to you. Life is a precious jewel, and health is the light sparkling from its many facets. Health is a state of vitality and aliveness that permeates and radiates from every aspect of your being—body, mind and spirit. Health is the heart and soul of life. If life is the subject, health is the meaning we give it. If life is a story, health is the beauty, passion, grace and love with which the story is told.

Health is joie de vivre. Health is richness, animateness, essence and beatitude. It's boundless energy. Health is the capacity to adapt and change and grow and heal and do and be and thrive in every conceivable way—physically, psychologically, spiritually and socially. Health is a deep connection with yourself, others, and with what's beyond the confines of this life—while you're still here. Health is the capacity to be honest with yourself and others. It's the capacity to self-reflect, learn from mistakes, forgive, apologize, move on, love, be open to new and greater possibilities, and allow yourself to be guided by them.

Symptoms and Disease Are Sometimes Necessary. Don't Chase Them Away

Health is so much more than avoiding symptoms and disease. Symptoms and disease are like warning lights on your car's dashboard that let you that change is necessary. Symptoms and disease are nothing to be avoided. They're messengers. If we receive their message rather than chasing them away, we can make effective changes in our lives and grow in sudden and unexpected ways. Symptoms and disease aren't signs of failure, nor are they shameful. Instead, we can take empowered action to better our lives when we meet symptoms and diseases with love, compassion and understanding. Thus symptoms and disease are often a necessary part of the healing process, and can catalyze much-needed change.

Can a Doctor Determine if You're Healthy?

If health is the absence of symptoms and disease, then only a doctor can pronounce you healthy. By limiting health to the lack of symptoms and disease, medicine has arrogated the power to dictate not only what health is, but who's healthy and who's not. The fact of the matter is that what it means to be truly healthy is well beyond what any doctor can affirm or deny.

Quality of Life: What Miraculous Health Is All About

Unlike the concept of health, which the world reduces to a conversation about physical symptoms and disease, ***quality of life (QOL)*** is a comprehensive, subjective *self-assessment* of how you relate to the physical, psychological, social and spiritual (or religious) aspects of your life[38]. Quality of life is something that each person must assess on their own. Yet, amid our busy lives, we rarely (if ever) stop and honestly contemplate soulful questions such as these:

- How do I feel about my life? Am I enjoying my day-to-day life? Is my life meaningful *to me*?
- Does my physical health interfere with or enhance my ability to do the things I find valuable?
- Does my psychological health interfere with or enhance my ability to do the things I find valuable?
- Am I satisfied with my social life, i.e., the activities I engage in with others?
- Do I have the time and freedom to develop a personally valued spiritual or religious practice?
- Do I have the time to pursue personally valued activities such as painting, hiking, reading or meditating?

- Do I have time to exercise in a way that's not stressful, or does finding time to exercise generate time pressure and stress?
- Do I work so much that I have little time for anything else?
- Is providing for my bare existence a stressful experience?
- Am I often in a hurry? Do I find it hard to relax and unwind?
- Am I worried about the future? Is anxiety an everyday companion?
- Am I happy with my primary relationships?
- Do I like where I live? Do I feel safe where I live? Am I in danger where I live?
- Am I happy with my level of education?
- Am I happy with my work life?
- Am I happy with my financial life?
- Am I pleased with the image I see in the mirror?

When was the last time you took a break from everyday life and did the sort of soul-searching that would put you more honestly in touch with yourself? It's only when we ask ourselves questions such as these that it's possible to assess the quality of our lives. Yet, sadly, many avoid such questions because the answers would point to the painful reality that the lives we're leading aren't inherently satisfying.

In what seems like a bizarre subplot from a dystopian novel, most humans get so caught up in the daily grind that we haven't the faintest idea if we're genuinely enjoying our earthly existence. We're so preoccupied with attending to the stuff of life that we switch our internal compass to autopilot and unconsciously navigate through the decades. Only when we take a break from life and look inside for honest answers to questions such as those above do we realize that change is necessary in our lives. This is the importance of evaluating our quality of life.

We're so busy between birth and death that few of us *genuinely* pause to ponder what life is about in the first place, and even fewer stop to ponder if their day-to-day lives engender a deep sense of satisfaction. What would you find if you put life on pause for a few days—or even a few weeks—and asked yourself if your day-to-day life engenders a deep sense of satisfaction? Until we make lifestyle interventions to increase our quality of life, we often somnambulate our way through life to the beat of a drum that may not even be our own.

Quality of Life Is an Enduring Internal State

Quality of life is an *enduring internal state*. It's not here today and gone tomorrow. Quality of life can't be found in externals such as money, looks or status. These factors come and go, and spending your life energy chasing after them leads you away from what you are, not towards it. When what you authentically are shines forth like a beacon, it permeates every aspect of your being. It's a light from within that's infinitely more valuable than chasing after the ephemeral. No matter how satisfied you are with your everyday existence, take time to hit the pause button and honestly assess your quality of life.

> You were born with potential. You were born with goodness and trust. You were born with ideals and dreams. You were born with greatness. You were born with wings. You are not meant for crawling, so don't. You have wings. Learn to use them and fly. —Rumi

An Ounce of Prevention Is Worth a Thousand Pounds of Cure

Making lifestyle interventions leads to miraculous health, but the opposite is equally true: *not* making lifestyle interventions opens the door to chronic diseases and a future of poor health. The fact is that it's a thousand times easier to prevent chronic diseases from taking root than to eradicate them once they do.

Once things like cancer, heart attacks, strokes or Alzheimer's disease occur, significant effort may be required to regain excellent health. However, by keeping your spirits up and taking empowered action on a daily basis, you'll be able to improve your current state of health. Thus if you haven't experienced a major health setback, I encourage you to begin taking empowered action to improve every aspect of your life and health—*today*.

Becoming healthier than ever before and remaining that way for as long as you shall live doesn't cost a penny—but not taking care of yourself invariably comes at a high price. It's often the case that we don't value our health until we realize that it's slipping from our grasp. When our health becomes like a car sliding into the ditch on a snowy highway, we'll suddenly do anything within our power to keep it on the road. But despite our best efforts, once our health slips past a certain threshold, it's far more challenging to right its course. Don't wait. Don't wait until your health is spinning out of control to take empowered action. The best time to act is always *now*, and *HP100* will show you which steps to take.

The Challenges of Making Lifestyle Interventions in the Modern World

Life gets busy, and there are only so many hours in a day. Days turn into weeks, and before we know it, years have slipped by. It's easy to get so wrapped up in the daily grind of life that we prioritize work, responsibilities and leisure activities over lifestyle interventions like exercise and diet. Adding one more thing to our already too-full plates can initially seem stressful. Still, if we don't set aside the time each week to cherish and safeguard our health, our choice not to do so must inevitably detract from our health and quality of life, which are our most precious commodities. Anything that appears to be more important than our health and quality of life isn't what it seems.

The Peace of Mind Gained From Making Lifestyle Interventions

Peace of mind is invaluable. When you're dealing with health issues (or worried about health issues that may develop in the future), lasting peace of mind can be hard to come by. Worry and concern are exhausting; when you focus on the Short List and experience genuine improvement in your health, worry and concern give way to relief. As your health issues lessen and optimal health emerges, a state of lasting peace permeates your being. Once this peace is experienced, the motivation to safeguard your health will never again be a problem.

Summing up the Miraculous Power of Lifestyle Interventions

When you make lifestyle interventions and focus on the Short List, you decrease the odds of developing chronic diseases such as cancer, stroke and diabetes[39,40,41,42,43]. You increase longevity, lifespan, healthy aging and healthspan, positively affecting risk factors and decreasing all-cause mortality. Lifestyle interventions decrease all-cause mortality between 78%[44] and 81%[45], *even if you already have diseases*[46,47].

The Scientifically Proven Benefits of Lifestyle Interventions:

- Greatly reduced odds of developing *chronic diseases*, e.g., cancer, stroke, diabetes and Alzheimer's disease
- Increased *longevity*, i.e., living longer than the people in your country of the same gender and race
- Increased *lifespan*, i.e., the period between birth and death
- Increased *healthspan*, i.e., the time prior to developing chronic diseases like cancer and heart disease
- Increased *healthy aging*, i.e., the continuance of a high degree of function and wellness into advanced age
- Decreased *all-cause mortality*, i.e., the diminished risk of death from any and all causes
- Increased *quality of life (QOL)*, i.e., a sense of deep satisfaction with your day-to-day life
- Decreased *risk factors*, i.e., the controllable factors that contribute to poor health and disease

The Synergy of Simultaneous Optimization Calls Forth An Emergence of Miraculous Health From Within

When you focus on the Short List and make lifestyle interventions, a previously unknown and unexpected degree of health can emerge from deep within and remain with you for the rest of your days. Helping call forth the emergence of miraculous health from deep within is precisely why this book has been written. In *Civil Disobedience and Other Essays*, Henry David Thoreau noted that "the mass of men lead lives of quiet desperation." Don't all of us lead such lives in one way, shape or form? Don't we all yearn to break free of our small selves and truly live? Don't we all know that something deep in our souls is desperate to break free of its shackles and shine so brightly that it illuminates the night sky?

Begin Focusing on the Short List Today

The only way to experience something different is to stop doing what you've always done. If you yearn to break free of the confines of your life and experience miraculous health, make lifestyle interventions. This is your life we're talking about, and it matters more than anything else. It matters that you eat right, exercise, pay close attention to your psychology, and grow spiritually.

Nearly all medical care and medical research are aimed at health conditions *that have already developed*[48]. We perform maintenance on our cars to prevent them from breaking down, but we wait until our health deteriorates and diseases develop *before we decide that something needs to be done*. Don't wait. Eat the best possible diet, move your body, smile, dance, forgive, let go, love and find reasons to be genuinely happy each day. What are you waiting for? Focus on the Short List. Begin today. You can do this, and *HP100* lights the way.

> Run from what's comfortable. Forget safety. Live where you fear to live. Destroy your reputation. Be notorious. I have tried prudent planning long enough. From now on I'll be mad. —Rumi

The Healthcare Delivery System Is on Life Support

Unless you've been living in an alternate reality, you know that the world's ***healthcare delivery system*** is on life support. The *healthcare delivery system* is an umbrella term that refers to every aspect of healthcare, including government organizations such as the National Institutes of Health, medical groups such as the American Medical Association, the pharmaceutical industry, private and government insurance providers, hospitals, outpatient patient care facilities, pharmacies, home health and more.

The healthcare delivery system benefits from a massive influx of funding, technological breakthroughs and some of the most brilliant minds on the planet. But at the same time, a shocking percentage of medical procedures, practices and policies are based on outdated research, or worse yet, no research at all. It's not that emerging procedures, drugs, equipment and insights modernize and replace outdated ones. Instead, a surprising number of procedures, drugs, equipment and insights *never worked to begin with*. For example, a landmark 2013 study published in *Mayo Clinic Proceedings* examined every article published in the prestigious *New England Journal of Medicine* (NEJM) between 2001 and 2010. Alarmingly, Mayo's study found that of the 363 articles published in NEJM that tested current clinical procedures—things that doctors and medical personnel have been doing for years—146 (40%) proved to have never worked at all[49].

Vinay Prasad, M.D., who published the study in *Mayo Clinic Proceedings*, had this to say:

> A large proportion of current medical practice, 40%, was found to offer no benefits in our survey of 10 years of the New England Journal of Medicine. These 146 practices are medical reversals. They weren't just practices that once worked, and have now been improved upon; rather, they never worked. They were instituted in error, never helped patients, and have eroded trust in medicine. Dr. Prasad adds, "Health care costs now threaten the entire economy. Our investigation suggests that much of what we are doing today simply doesn't help patients. Eliminating medical reversal [procedures that have been instituted that have never worked or helped] may help address the most pressing problem in health care today[50]."

The point isn't to bash the healthcare delivery system in its teeth; that's counterproductive and doesn't solve a crucial problem. Many wonderful people in the healthcare delivery system work tirelessly to provide healthcare to humans around the globe. But at the same time, the healthcare delivery system has become overburdened by pharmaceutical company meddling, out-of-control costs, profit motives, red tape, poor patient outcomes, lack of insurance, lack of access, increasing mortality rates, lack of emphasis on prevention, increased reliance on drugs and surgery, overworked healthcare professionals, poor communication, egocentric politics, deplorable public relations, lack of big-picture thinking and so on that the healthcare delivery system has lost touch with (and lost the trust of) many humans around the globe.

Healthy Past 100 Provides a Solution to the World's Healthcare Crisis

There's a better way, and *HP100* is a part of the solution to the world's healthcare crisis. While the healthcare delivery system has been chasing its tail, the scientific community has been quietly publishing a treasure trove of cutting-edge healthcare research that can guide you through the process of healing and optimizing your life in ways that transcend our current understanding of what's possible regarding our health and quality of life.

Why *Healthy Past 100* Is Based on the Latest Science

The problem is, however, that precious little of this research makes its way into the healthcare delivery system, and even less of it makes its way into the general public. It exists, it's published, but it's languishing in scientific journals that scarcely anyone other than scientists ever read. That's where *HP100* comes in. *Healthy Past 100* is a comprehensive healthcare manual based on life-changing breakthroughs from the scientific literature. *HP100* distills the revolutionary information from thousands of studies into a step-by-step guidebook that can be used to heal your body and optimize your health. So how do you apply this information to your life? By making lifestyle interventions. By doing only what works. By focusing on the Short List.

Good Science Can Change the Face of Health and Healthcare

HP100 was borne of peer-reviewed research. Since June 2015, there have been many days in which I've perused 50 or even 100 scientific studies. Sometimes more. Some studies are informative, some are a rehash of the same old stuff and don't offer the world anything new, some reek of bias and pander to outdated information, and some are chock full of cutting-edge information that can change the face of health and healthcare. This book is based on studies that fall into the latter category.

More than half of all the scientific studies performed today are funded by the pharmaceutical industry. These "studies" aren't really studies because they aim to sell medications that treat diseases that have already developed, earning a tidy profit in the process. The true purpose of performing a scientific study is to test a hypothesis, not to achieve a desired outcome that will lead to billions of dollars of revenue.

HP100 isn't based on studies performed to prove the effectiveness of medications or achieve a desired outcome. Instead, this book is based on independent studies funded by research grants from governments, charitable funds and organizations that aren't vested in obtaining specific results and marketing medications for profit. *HP100* is based on top-notch research that's been performed solely to sleuth out fact from fiction, for the sake of truth, and for the sake of bettering your health and optimizing your life.

The Peer Review Process

For more than 300 years, science has relied on the ***peer-review process*** to ensure that published scientific studies are accurate, do not make unwarranted or false claims, are free of personal bias and are of the highest possible standards. The peer-review process involves subjecting an author's work, research or ideas to the scrutiny of experts in the same field of study[51]. Peer-reviewed research is not performed to sell products, make profits, or arrive at specific conclusions. Refreshingly, peer-reviewed research is performed to determine what works and what doesn't and to make a contribution to the truth. While the peer-review process isn't perfect, it's an excellent safeguard against bias and misinformation that masquerades as science and misinforms the masses. To the greatest extent possible, *Healthy Past 100* is based on peer-reviewed research.

Cited Evidence

When an in-depth research study is undertaken, it will invariably *cite* the work of other scientific studies. Scientific studies commonly cite 100, 200, and sometimes more than 300 other studies as sources for the information upon which their work is based. *HP100* cites more than 3,000 different peer-reviewed scientific articles published in highly respected science journals worldwide, demonstrating that the evidence this book is based on has been sourced exclusively from verifiable and trustworthy science journals.

The Latest Cutting-Edge Healthcare Information at Your Fingertips

If you have a story that learning is hard work—especially about science and healthcare—it's time to let that story go. To make changes that work today, tomorrow and for decades to come, you must have the most up-to-date and accurate healthcare information at your fingertips—and it's precisely this information that *HP100* puts in your hands. *HP100* distills the latest cutting-edge healthcare research from thousands of scientific journals worldwide and organizes it step-by-step so you can quickly and easily apply it to your life. *HP100* teaches you exactly what you need to know to make empowered healthcare choices, and does so in a clear, easy-to-follow manner.

You Don't Have to Be a Scientist or Healthcare Professional to Use This Book

You don't have to be a scientist or healthcare guru to understand the information in this book and apply it to your life. All of the scientific and healthcare terms this book uses are defined in straightforward language in the coming pages, and there's a glossary at the end of the book that you can refer to at any time. When you see a term that you're unfamiliar with—and I promise that you'll see several of them—*don't stress about it!* Instead, know you're about to learn something essential to help you heal and optimize your life. Stress comes from a lack of knowledge, and empowerment comes from having accurate, life-changing information at your fingertips.

For example, a term you'll become very familiar with in the Metabolism Section is *gluconeogenesis* (GLUE-co-nee-oh-*JEN*-eh-sis). Gluconeogenesis is the creation of blood sugar by the liver. Every second of every day, the liver creates lots and lots of blood sugar. But when we consume a diet rich in sugar, carbohydrates and alcohol, the liver gets confused and produces greater and greater amounts of blood sugar. This is excess gluconeogenesis, which leads to diabetes, obesity, cholesterol imbalances and many other serious health problems.

Most healthcare professionals are unfamiliar with the damaging effects of excess gluconeogenesis, and virtually no one knows how to return the liver's blood sugar production to normal once it becomes excessive. But when you've read the Metabolism Section, you'll know more about gluconeogenesis than most people on the planet, and you'll also know the steps required to heal it. Having the information at your fingertips to heal things like out-of-control gluconeogenesis is unspeakably powerful. This book puts that power in your hands, and helps you apply it to your life with surprising ease.

Become a Healthcare Brainiac

Some books are written for "dummies," but *Healthy Past 100* has been written for those who yearn to become healthcare brainiacs. This book is for those who seek empowerment through accurate, cutting-edge information that can guide them to optimal health. It's for people who desire to make informed healthcare decisions with a balance of left-brain science and right-brain big-picture orientation. It's for people who recognize that health and healthcare merge the physical, psychological and spiritual selves.

Bolded and Italicized

If a word or term is ***bolded and italicized***, it's included in the glossary. The glossary contains hundreds of concise explanations about the concepts contained in this book. If you're unfamiliar with a word or term that's used, the glossary can help shed light on its meaning. For the most part, bolded and italicized terms have been bolded and italicized the first time they're introduced. Some terms that appear in multiple sections have been bolded and italicized in the various sections where they appear.

Healthy Past 100 Is a Big Book. Where Do You Begin?

Congratulations! You've made your way through the Introduction of *HP100* and are ready to begin addressing the items on the Short List. If you haven't done so, briefly skim each section and get a feel for the material contained in each section. Once you have, read the following interrelated sections in order:

- The Metabolism Section—what metabolism is, how it becomes damaged and how to heal it
- The Core Essentials Section—how to include the healthiest protein, fat and fiber in your diet
- What Not to Eat Section—what foods and ingredients it's necessary to avoid to be healthy past 100
- The Metabolic Masterplan Cookbook—the world's healthiest keto cookbook

Once you've read these sections, you're ready to move on to *HP100's* remaining material. Feel free to read the rest of the book in the order that best suits your needs. A word of advice as you make your way through the material: *take your time*. This book was written with one purpose in mind: to provide you with everything you need to know to optimize your life and health. As you read each section, more and more pieces of the healthcare puzzle will fall in place in your mind.

How to Contact Us

If you would like to contact us, please go to www.healthypast100.com

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Section One:
Metabolism—the Energy of Life

Chapter 1:
Healing and Optimizing Your Metabolism

If you'd like to elevate your life and health to rarified levels for decades to come, keep reading. If you'd like to radically restructure your life from top to bottom, keep reading. If you'd like to undeniably know that your diet optimizes every health outcome that can be measured, keep reading. If you'd like to have more energy, keep reading. If you have difficulty losing weight, keep reading. Finally, if you'd like to know why diabetes, obesity, Alzheimer's, Parkinson's, heart attacks, strokes and other diseases are so common—especially if you'd like to avoid these diseases—keep reading.

The information in this section is the real deal, and I promise that if you take the time to read it, the rest of your life can be healthier, brighter, and more fulfilling than anything you've imagined. *Much more so*. In an ultimate sense, all beings are pure Spirit, yet everyone who comes to earth experiences the profound limitations of existing within a body. A crucial factor that determines whether you feel limited or free in your body is the amount of ***energy*** you have.

What is energy? It's a vital life force that flows through you and animates your being. You are not simply a body; you are the energy that flows into and through your body. Energy is aliveness. It's the radiant spark of God. Energy is spirit, vitality, oomph, robustness, luminosity, power, capacity, vibrancy, mettle, hardiness, positivity, resilience, soul, drive, fortitude, joyfulness, vivacity, radiance, sturdiness, get up and go, enthusiasm, grit, endurance, strength, stamina, vigor, might, exuberance, irrepressibility, resolve, brightness, boundlessness and more.

Life is the Meeting Place of Spiritual Energy and Metabolic Energy

Life is energy. The more energy you have, the more alive you are. Life-sustaining Spiritual energy flows into your body, but that's only part of the story. Every cell must create tremendous amounts of *biological energy* for you to remain healthy and alive. Biological energy is ***metabolic energy***. Thus life is a combination of Spiritual energy—call it God, Spirit, Great Spirit, Yahweh or any other term—as well as metabolic energy, i.e., the energy created within every cell of your body.

Life is the Meeting Place of:

- Spiritual energy
- Metabolic energy

Metabolism is the Creation of Metabolic Energy

The ultimate purpose of ***metabolism*** is the creation of ample amounts of metabolic energy in every cell of the body. Thus metabolism is what keeps your body alive. When we lack Spiritual energy, our lives lack meaning and purpose. When we lack metabolic energy, we lack the wherewithal to do what we're here to do on this planet. We lack the gumption to change and improve our lives in lasting, meaningful ways. We're alive but not nearly as alive as we have the potential to be. We have dreams and purpose but lack the energy to bring them to fruition.

Everyone gets to a certain age and realizes they don't have the same energy they once did. Maybe it happens at age 40 or 50 or even 60, but 99% of the patients I've worked with describe not having the same oomph they once did. When we lack metabolic energy, optimal health remains elusive. Aches and pains become constant companions, and losing weight becomes harder and harder to do. We don't sleep as well, and it's harder to bounce back from strenuous activity. We're alive, but our *joie de vivre* and youthful exuberance aren't what they used to be. So how do you get your energy back? *Make more metabolic energy in your cells*.

The Western Diet Damages Metabolism, Impairs Health and Zaps Energy

Nearly everyone in industrialized nations follows some version of the Western diet, i.e., a diet high in carbohydrates, sugar, processed foods, vegetable oils, trans fats, fast foods, additives, preservatives and other unsavory ingredients. The Western diet is inextricably linked to all-cause mortality and underlies every disease humans develop. The Western diet's unique combination of factors damages metabolism in various ways; this damage interferes with the production of metabolic energy, and diminished metabolic energy sets your health on a downward spiral.

What You'll Learn in This Section

The Metabolism Section is a thorough treatise on what metabolism is, how it becomes damaged by the Western diet, the adverse effects of impaired metabolism, how to heal your metabolism, and how to keep it optimized for decades to come. The Western diet damages the health of billions of people around the globe. This damage leads to obesity, insulin resistance, type 2 diabetes, the inability to lose weight, oxidative stress, poor energy, numerous diseases and more. *Healthy Past 100* refers to this pervasive damage as ***metabolic mayhem***. The Western diet directly leads to metabolic mayhem, and *HP100* leads to miraculous metabolism.

What You'll Learn in This Section:

- What metabolism is and why it's so important to your life and health
- The crucial importance of metabolic energy
- The importance of metabolic efficiency
- How the Western diet damages metabolism
- The adverse effects of damaged metabolism (metabolic mayhem)
- How metabolism is healed and optimized

When you've read this section, you'll know more about metabolism than most healthcare professionals. You'll know what to eat, how much to eat, and why to eat it. You'll know all about carbohydrates, sugar, ketones, fats, insulin, insulin resistance, metabolic syndrome, type 2 diabetes, nonalcoholic fatty liver disease, blood sugar, blood sugar regulation, stress hormones, cholesterol, triglycerides (fat) and more. Away we go!

A Healthy Metabolism Is an Efficient Metabolism

Each of your cells must create tremendous amounts of metabolic energy in each split-second of the day to keep your body alive and well. When your cells have the means to produce all the metabolic energy they require, your health soars to new heights. But when your cells can't make enough metabolic energy, your body ages—regardless of how old you are—and sickness and disease begin to develop. Conversely, when your cells effortlessly produce all the metabolic energy they require, your metabolism is healthy, and you have high ***metabolic efficiency***. But metabolism becomes inefficient when your cells can't make enough metabolic energy to perform their many functions.

Fats and Ketones Optimize Metabolic Efficiency

An inefficient metabolism places an enormous strain on your health; this makes it hard to create enough metabolic energy to get through the day and remain in optimal health. So what's the easiest, safest and most effective way to maximize your metabolic efficiency? Undoubtedly, it's saying *goodbye* to carbs and sugars and *hello* to fat. Switching to a fat-burning diet leads to more health benefits *than anything else that you can do*. The truth is that nothing can match the unprecedented benefits of fat burning. Nothing whatsoever.

Mighty Mitochondria: Where Metabolism Happens

Metabolism takes place in microscopic parts of your cells known as ***mitochondria***. Mitochondria are the mighty makers of metabolic energy. Sally sells seashells by the seashore, and mammals make metabolic energy in their mitochondria. An efficient metabolism requires an abundance of healthy, efficient mitochondria, and healthy, efficient mitochondria burn fats and ketones as their primary fuel sources.

Mammals Make Metabolic Energy in Their Mitochondria From These Fuels:

- Fats
- Ketones
- Protein (protein is broken down into amino acids, which can be converted to energy)

- Carbohydrates and sugars
- Alcohol

Mitochondria Make More Energy From Fats and Ketones Than Carbs and Sugar

Your mitochondria make more metabolic energy from fats and ketones than carbohydrates and sugars. When your mitochondria burn fats and ketones, you'll have more physical and mental energy, and you'll have more mental clarity, too. This clarity is unmistakable, obvious and clear. I have much more physical and mental energy than before switching to the ***Metabolic Masterplan Diet*** (*Healthy Past 100's* cutting-edge diet). I bounce back from stressful situations and strenuous exercise *far* better than ever before and only have aches and pains when I've pushed my body to its limits.

My energy levels don't come and go or fade in and out. My energy remains consistent every day of the year, which wasn't the case before switching to fat as my primary fuel source. When your cells burn fat and ketones, your metabolic efficiency becomes maximized. Fat is a natural enhancer of metabolism and therefore enhances your life and health, but the same can't be said of carbohydrates. The fuel you burn in your mitochondria—fat, ketones, protein, carbohydrates or alcohol—not only makes a huge difference in your energy levels, but affects every aspect of your life and health, including how long you can live.

Note: the Metabolic Masterplan Diet (MMD) is a highly specialized ketogenic diet that's been carefully designed to heal and optimize every aspect of your metabolism. The MMD is based on the Core Essentials, which are the healthiest proteins, fats and fibers you can consume. The Core Essentials are reviewed in detail following the Metabolism Section. In addition, the Metabolic Masterplan Cookbook, a complete cookbook based on the Core Essentials, follows the Core Essentials Section.

To Optimize Your Metabolism, Burn Fats and Ketones

Your metabolism becomes optimized when you make metabolic energy, i.e., ***ATP (adenosine triphosphate)***, from fats and ketones; this is beyond dispute in the scientific literature. As more and more information continues to pour in from the scientific literature about the phenomenal benefits of making ATP from fats and ketones, it's become commonplace for members of the Navy Seals and special forces personnel, as well as endurance athletes who compete in the world's most grueling events, to rely on fats and ketones for the unmatched benefits they provide[1,2,3].

The following quote is excerpted from an article published in *The Journal of the Federation of American Societies for Experimental Biology* in 2016. The title of the article is *Novel ketone diet enhances physical and cognitive performance:*

> Ketone bodies are the most energy-efficient fuel and yield more ATP per mole [a mole is a unit of measure commonly used in science] of substrate than pyruvate [blood sugar] and increase the free energy released from ATP hydrolysis [the creation of ATP, i.e., energy][4].

The 2018 book entitled *Ketogenic Diet* by Wajeed Masood and Kalyan R. Uppaluri compares the amount of ATP produced from two ketones, acetoacetate and beta-hydroxybutyrate, with the amount of ATP produced from the same amount of glucose (blood sugar):

> Ketone bodies produce more adenosine triphosphate [ATP] in comparison to glucose [blood sugar], sometimes aptly called a "super fuel." One hundred grams of acetoacetate [a type of ketone] generates 9400 grams of ATP, and 100 grams of beta-hydroxybutyrate [a type of ketone] yields 10,500 grams of ATP; whereas, 100 grams of glucose produces only 8,700 grams of ATP. This allows the body to maintain efficient fuel production even during a caloric deficit. [In other words, the body can continue to make energy even when food isn't available.] Ketone bodies also decrease free radical damage and enhance antioxidant capacity[5].

There we have it! Ketones are the most energy-efficient fuel and yield more metabolic energy (ATP) than blood sugar (glucose). Virtually every client I work with complains of a lack of energy, fuzzy memory, and the inability to do what they used to do. People know they're unable to bounce back the way they once did, but they don't know what to do

about it. As much as I didn't want to admit it, this was beginning to happen to me, too. As I started developing the Metabolic Masterplan Diet in July 2015, I was so surprised by my increased physical and mental energy that I wondered if it would gradually fade away. But, years later, the energy just keeps right on coming, and I thank my lucky stars for increased metabolic efficiency.

Why Metabolic Efficiency Matters: Mitochondria, ATP, Free Radicals (RONS), Oxidative Stress and Antioxidants, Metabolic Efficiency and Life Itself

An inefficient metabolism diminishes ATP production and creates excess metabolic wastes within the mitochondria[6]. These metabolic wastes are colloquially known as ***free radicals;*** their more scientific names are *reactive oxygen species (ROS)* and *reactive nitrogen species (RNS)*. ROS and RNS are collectively known as ***reactive oxygen and nitrogen species***, i.e., ***RONS***.

Even though RONS are metabolic wastes, they're essential to your health. But when too many of them are created, the mitochondria's delicate DNA is easily damaged, causing mitochondria and cells to die. Excess production of RONS is known as ***oxidative stress***. Oxidative stress is synonymous with aging, the progression of sickness, disease and death. By damaging every part of the body, oxidative stress is one of the primary ways metabolic inefficiency destroys human health.

To put RONS in perspective, let's reiterate a point from the above paragraphs: the oxidative stress produced by excess RONS *is theorized to cause aging and death*[7]. This theory is known as the ***oxidative stress theory of aging*** or the free radical theory of aging[8]. This theory unambiguously states that the damage caused by RONS eventually leads to sickness and diseases, ultimately resulting in death. Oxidative stress is directly involved in several diseases, including cardiovascular diseases, chronic obstructive pulmonary disease (COPD), chronic kidney disease, neurodegenerative diseases, cancer, as well as *sarcopenia* (loss of muscle tissue and wasting) and frailty[9,10]. (The ketogenic diet prevents sarcopenia and preserves skeletal muscle into advanced age[11].)

An inefficient metabolism leads to the production of excess RONS in the mitochondria, and excess RONS is quite literally synonymous with the process of aging, disease progression, sickness and death. That's why metabolic efficiency truly is a matter of life and death. An all-important point is that the quantity of RONS produced in your mitochondria is reduced when you switch to the Metabolic Masterplan Diet and make ATP from fats and ketones. RONS and metabolic efficiency are reviewed in detail in the coming pages.

Antioxidants Are Made in the Mitochondria

Given that oxidative stress is the cause of aging and death, it comes as no surprise that mitochondria produce several ***antioxidants*** whose job is to neutralize the damaging effects of excess RONS. The most important antioxidants are *superoxide dismutase-2 (SOD2)*, ***glutathione peroxidase*** (commonly abbreviated as glutathione), and *catalase*. Hundreds of antioxidants are produced in the mitochondria and other parts of the body, but SOD2, glutathione and catalase are the antioxidant all-stars that neutralize the damaging effects of excess RONS.

The Main Antioxidants Produced Within the Mitochondria Include:

- Glutathione peroxidase
- Superoxide dismutase-2 (SOD2)
- Catalase

Antioxidants Must Be Made in Every Instant Of Your Life

Not an instant passes in which your mitochondria aren't churning out vast quantities of ATP; as they do, they also churn out vast amounts of RONS. To neutralize the RONS created in the process of making ATP, mitochondria also produce vast quantities of antioxidants. Astoundingly, when our cells make ATP from fats and ketones, they produce more ATP, fewer RONS, and more antioxidants. Furthermore, when fats and ketones are increasingly used to create ATP, an adaptive response known as *mitochondrial biosynthesis* occurs, wherein more mitochondria are produced in critical areas throughout the body. This enhances ATP production in the areas where it's needed most. This combination of factors is a fundamental reason why the Metabolic Masterplan Diet is associated with powerful life-changing health benefits.

Making ATP From Fats and Ketones Produces These Life-Changing Health Benefits:

- The production of more ATP
- The production of fewer RONS
- The production of more antioxidants
- The creation of more mitochondria in key areas (mitochondrial biosynthesis)[12,13].

Optimized Metabolic Efficiency: Why the Metabolic Masterplan Diet is Such an Important Lifestyle Intervention

The powerful health benefits that stem from creating more ATP, more antioxidants and fewer RONS in your mitochondria—and having more mitochondria in key areas—cannot be overemphasized. These benefits are yours for the taking simply by switching to the Metabolic Masterplan Diet, and underscore why doing so is such a crucially important lifestyle intervention. In addition, metabolizing fats and ketones improves healthspan, healthy aging, longevity, lifespan and quality of life (QOL), and decreases all-cause mortality.

Antioxidant-Rich Foods Don't Neutralize RONS

Unlike the antioxidants produced in our mitochondria, the antioxidants in the foods we eat have no capacity whatsoever to neutralize the powerful RONS created in our mitochondria. For starters, dietary antioxidants are too weak to neutralize RONS. Furthermore, it's impossible to eat enough of them, not to mention transport them to the vast numbers of mitochondria in your body each split second of the day to neutralize the RONS produced there. Some antioxidants like vitamin E are essential precursors of the powerful antioxidants your body creates, but when dietary antioxidants are taken in excess, they can cause more, not less oxidative stress[14]. Maximizing antioxidants in your cells happens by metabolizing fats and ketones, not by consuming antioxidant-rich foods.

RONS are Electronegative Anions

The universe is constructed of tiny bits of matter and energy known as *elements*. Based on the number of positively charged particles (protons) and negatively charged particles (electrons) that elements contain, they have a balanced, positive or negative electrical charge. It's common for elements to gain and lose electrons. Elements that have taken on extra electrons have an electronegative charge; these elements are known as *anions*. For example, oxygen, chlorine and nitrogen frequently acquire additional electrons, thus becoming strongly electronegative anions.

RONS are damaging to your health because of their exceptionally strong *electronegative charges*. Thus RONS can easily damage healthy cells and tissues, causing significant health problems, aging, and, ultimately, death. Fluorine is the most strongly electronegative element in the universe, with oxygen taking second place. Chlorine is the third-most electronegative element, and nitrogen comes in 4th place. The purpose of antioxidants is to bind with RONS in your body and neutralize their electronegative charges.

The two main RONS produced in the mitochondria are superoxide (O2-) and hydrogen peroxide (H2O2)[15], though many different RONS are formed within the mitochondria during metabolism. When RONS are produced in small amounts, and when they're produced in areas where they can be easily and quickly neutralized, they're crucial to healthy immune system function. But when RONS are produced in excess, especially when they're generated in areas where they can't be quickly neutralized, serious health issues ensue. This vital point is reviewed in detail in *The Art of Healing and Optimizing Your Gut*.

Common RONS Include:

- Superoxide—O2
- Hydrogen peroxide—H2O2
- Hydroxyl radical—OH
- Peroxynitrite—ONOO
- Nitric oxide—NO

As an aside, many alternative healthcare providers rely on hydrogen peroxide IVs and nebulizers to introduce hydrogen peroxide (H2O2) into the body. Given the damaging effects of RONS, it's strongly recommended that you

exercise extreme caution with any procedure, no matter how much "research" stands behind it, if it introduces or increases the production of RONS in your body. Excess RONS are deadly toxins, and the idea is to minimize, not increase them.

Mitohormesis: Why Burning Ketones Optimizes Mitochondrial Function

A fascinating science article published in the February 2018 *Journal of Nutrition and Metabolism* describes ***mitohormesis*** (mito-HOR-*MEE*-sis), which is the spontaneous optimization of mitochondrial function that results when fats and ketones are metabolized (used to create ATP)[16,17]. An essential feature of mitohormesis is that when fats and ketones are metabolized rather than glucose, the balance of RONS and antioxidants within the mitochondria naturally optimizes itself. As a result, the amount of RONS decreases, and the amount of antioxidants increases. Mitohormesis thus increases lifespan and longevity, and decreases all-cause mortality (the components of miraculous health)[18,19,20,21,22,23,24,25,26].

The secret is out: fat is good for you. Few of us would have believed it, but fat is essential to living a long and healthy life. Unbiased science cuts through the fog and gives us the objective, unadulterated truths we've been desperately seeking. Now all we have to do is learn how to apply them to our lives, which is what *HP100* shows you how to do. I've included a few direct quotes from the above-referenced science article on mitohormesis so you can read for yourself what science has to say about the benefits of a fat-based diet:

> Because mitochondria produce the majority of ATP, impaired mitochondrial function is implicated in the majority of today's most concerning chronic and degenerative health conditions including obesity, cardiovascular disease, cancer, diabetes, sarcopenia [muscle wasting], and neurodegenerative diseases[27,28]. Much of this association between mitochondrial function and disease can be attributed to excessive mitochondrial production of reactive oxygen species (ROS) [RONS][29].
>
> By dramatically shifting energy metabolism towards ketogenesis and fatty acid oxidation, ketogenic diets are likely to have a profound effect on mitochondrial function[30].
>
> Nutritional ketosis [a ketogenic diet] is a safe and physiological metabolic state induced through a ketogenic diet low in carbohydrate and moderate in protein. Such a diet increases reliance on mitochondrial respiration [the production of energy within the mitochondria] and may, therefore, induce mitohormesis[31].

The above quotes describe lowering the risks of chronic and degenerative diseases, profoundly improving mitochondrial function, and state that a ketogenic diet is safe. In addition, the following quote reinforces that chronic diseases, e.g., cancer and heart disease, are improved with diet and exercise, especially a ketogenic diet (a diet that induces the metabolism of fats and ketones):

> Among the chronic and degenerative diseases in which impaired mitochondrial function is a contributing factor, many respond favorably to lifestyle interventions focused on diet and exercise. The therapeutic potential of nutritional ketosis [a ketogenic diet] stands out in this regard. For example, in just the first 10 weeks of an ongoing clinical trial with hundreds of type 2 diabetics following a ketogenic diet, glycated hemoglobin (HbA1c) decreased to below the diagnostic threshold in more than a third of patients, and prescription medication was reduced or eliminated for more than half of patients [12]. Convincing arguments for a ketogenic diet to be the default treatment for diabetes are a decade old [13] and have continued to gain support since then [14]. Similar arguments are developing for obesity [10, 11], neurodegenerative diseases [19, 20, 27–30], cardiovascular disease [15–17], cancer [18–26], and even aging [31, 32]. Although the mechanisms through which a ketogenic diet may improve these conditions expand beyond mitochondrial function, the great extent to which nutritional ketosis increases reliance on mitochondrial metabolism strongly suggests that mitochondrial adaptation is a central factor[32].

Impressively, the above quote describes that when hundreds of people with type 2 diabetes switched to a ketogenic diet, half experienced such significant improvements that prescription medications were reduced or no longer necessary. This is a great example of the power of unbiased scientific investigation and its potential to positively affect

your life. If you're a glutton for nerdy punishment, this scientific article is definitely worth taking the time to read, or at least skim through it:

Nutritional Ketosis and Mitohormesis: Potential Implications for Mitochondrial Function and Human Health, by Vincent J. Miller,1 Frederick A. Villamena,2 and Jeff S. Volek1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5828461/

Why Other Diets Don't Induce Mitohormesis

Vegan, vegetarian, Paleo and virtually all other popular diets don't limit the intake of carbohydrates and sugar to a great enough extent (nor do they sufficiently limit protein intake) to induce a state of mitohormesis; thus, they don't give rise to the same life-changing benefits as ketogenic diet, especially one that's been as carefully constructed as the Metabolic Masterplan Diet. If your diet can't provide peer-reviewed proof that it enhances health outcomes like healthy aging and all-cause mortality, it may not be as healthy as you believe. The point isn't to get into a war of words; it's to allow accurate information to guide us to a miraculous health that lasts past our 100th birthday.

Mitochondria: The Little Furnaces That Keep Us Warm

Without mitochondria, there would be no human race. In fact, there would be no warm-blooded life, because mitochondria generate the heat that mammals require for warmth. If you're often cold, it may be because your mitochondria can't build a big enough metabolic fire to keep you warm and toasty, especially when the mercury drops. This is because your mitochondria are the warmest part of your body, especially when you're exercising and creating large amounts of ATP. Whereas your core temperature hovers around 98.6°F, studies are finding that human mitochondria become as warm as 122°F[33,34]. The more you exercise, the more mitochondria your cells create, enhancing your ability to stay warm, even in a cold environment.

Summarizing the Science of Burning Fats and Ketones

The science that explains how ATP (adenosine triphosphate), RONS (reactive oxygen and nitrogen species) and antioxidants are created in the mitochondria gets deep quickly. First, you need to know that the fuel your cells use to produce metabolic energy results in pivotal differences in the production of ATP, RONS and antioxidants. Metabolizing fats and ketones positively affect every possible aspect of your life, and these positive effects cannot be generated by any other means.

Metabolism Recap #1: The Basics of Metabolism

- A crucial factor determining whether we feel limited or free in our bodies is the energy we have.
- Energy is the vital life force that flows through you and animates your being.
- There are two types of energy: Spiritual energy and metabolic energy.
- Metabolic energy (ATP) is made by mitochondria in each cell of the body.
- The ultimate purpose of metabolism is to produce metabolic energy (ATP) in the mitochondria.
- Thus metabolism is what keeps your body healthy and alive.
- Vast quantities of ATP are required to power your body and keep you healthy.
- The Western diet damages metabolism (and our bodies) in various ways.
- The Western diet interferes with the production of metabolic energy, contributing to disease and diminishing health.
- When your body can't produce enough ATP, every aspect of your health suffers, and sickness and disease begin to take root, regardless of age.
- Significant health benefits are associated with creating ATP from fats and ketones.
- These include:
    - The production of more ATP
    - The production of fewer reactive oxygen and nitrogen species (RONS)
    - The production of more antioxidants, i.e., the chemicals that neutralize RONS (free radicals)
    - The production of more mitochondria (mitochondrial biosynthesis)
- This is known as mitohormesis. Mitohormesis optimizes mitochondrial function.
- Mitohormesis increases healthspan, healthy aging, longevity, lifespan and quality of life; it also decreases all-cause mortality.

- Only the ketogenic diet is scientifically proven to increase ATP and antioxidant production while reducing the production of free radicals (RONS).
- Excess RONS lead to oxidative stress, which leads to aging, disease and ultimately death.
- The primary antioxidants produced in the mitochondria to neutralize RONS are glutathione peroxidase, superoxide dismutase-2 (SOD-2) and catalase.
- The antioxidants you eat do not impact the RONS (free radicals) produced within your mitochondria.
- Excess consumption of dietary antioxidants may increase oxidative stress.
- Only a ketogenic diet can induce mitohormesis. Thus vegetarian, vegan, Paleo and other diets cannot usher in the life-changing benefits of a highly specialized ketogenic diet like the Metabolic Masterplan Diet.
- A healthy metabolism is an efficient metabolism. Mitohormesis significantly increases metabolic efficiency.
- Impaired mitochondrial function is associated with many diseases.

What's Next?

Now that we've introduced the basics of metabolism, we'll focus on the impressive body of peer-reviewed scientific evidence supporting the ketogenic diet.

Chapter 2:
The Science Supporting the Ketogenic Diet

Unbiased Science: Your Guide to Miraculous Metabolism

Countless diets and miracle products are available today, many claiming to be the best approach for you and your family. It's easy to make big claims, but backing them up with *peer-reviewed* scientific study after scientific study is the stuff of dreams—unless it's the ketogenic diet we're discussing. The number of frankly impressive peer-reviewed scientific studies published about the miraculous benefits of the ketogenic diet borders on astonishing. In fact, these studies were the spark that led to this book.

Peer-reviewed science isn't about playing games with data to sell products or sway public opinion. Peer-reviewed science has the discovery of truth as its goal. It aims to tease apart what *seems* to work from what *does* work. In the age of information overload, it's more important than ever to know that the information you're using to guide your healthcare choices is as accurate as possible. To give you a feel for the noteworthy science published about the ketogenic diet, excerpts from several studies are included in the coming pages. Take the time to read through this remarkable information about the various health benefits of the ketogenic diet.

What Is a Ketogenic Diet, Anyway?

A ketogenic diet is any diet that restricts carbohydrate intake to the extent that the liver reduces its production of blood sugar and begins converting fat into ketones. As the liver decreases blood sugar output and begins creating ketones, i.e., *ketogenesis*, the cells utilize ketones and fat to generate ATP. The many moving parts of the ketogenic diet are reviewed in fine detail in the coming pages.

Is the Metabolic Masterplan Diet Safe?

I understand your hesitation if you're unsure if it's safe to increase your fat intake, especially saturated fat. I too was hesitant, and the information in this section raised my comfort level to the point that I knew, beyond any doubt, that powering my body with fat was the best decision I could make for my health. That being said, the ketogenic diet is such a radically different way of eating that many need proof that consuming butter, whipping cream, beef and other fatty foods is a wise thing to do. That proof is what follows. We'll begin by reviewing the effects of the ketogenic diet on the production of antioxidants in the brain.

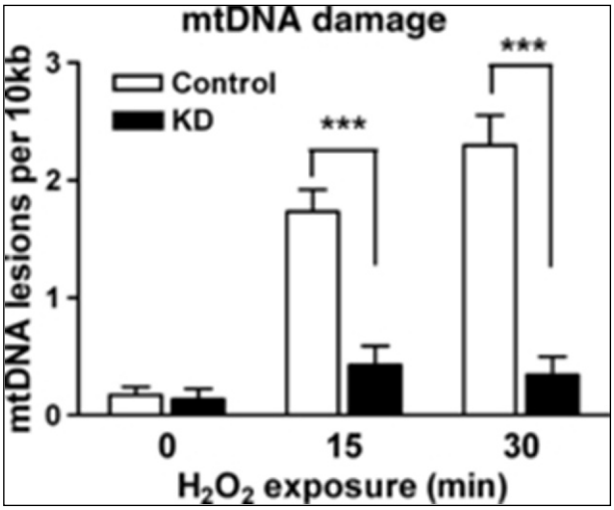
The Ketogenic Diet and the Production of Antioxidants Within the Brain

A landmark study published in the July 2008 issue of *the Journal of Neurochemistry* investigated the effects of the ketogenic diet on the relationship between antioxidants and reactive oxygen species (ROS) (a subset of RONS) in the *hippocampus*. (The hippocampus is a vital brain center that processes information and emotion.) The study found that when rats were placed on a ketogenic diet, the amount of glutathione produced in their hippocampal mitochondria *doubled* compared to rats fed a standard diet[35].

This is uncommonly important, because glutathione is the master antioxidant of the body; when glutathione levels *double* in critical neurological areas, oxidative stress (RONS) is reduced, cognitive capacity increases, and researchers (and people like me) become giddy with excitement. To determine the effects of a two-fold increase of glutathione within hippocampal mitochondria on overall brain function, researchers subjected the rat's hippocampal mitochondria to hydrogen peroxide (H_2O_2), the most common reactive oxygen species (ROS) produced within mitochondria.

They found it extraordinary: when hippocampal mitochondria taken from rats fed a standard diet were exposed to hydrogen peroxide, significant, progressive damage occurred. But when hippocampal mitochondria from rats fed a ketogenic diet were exposed to the same dose of hydrogen peroxide, *little damage occurred, even after 30 minutes of exposure!* This is a remarkable finding, especially given the sharp rise in neurodegenerative conditions such as Parkinson's disease. These findings strongly suggest that metabolizing fats and ketones provide health benefits that cannot occur when the brain relies on blood sugar as its primary fuel. These findings are summarized in Figure 1.

Figure 1

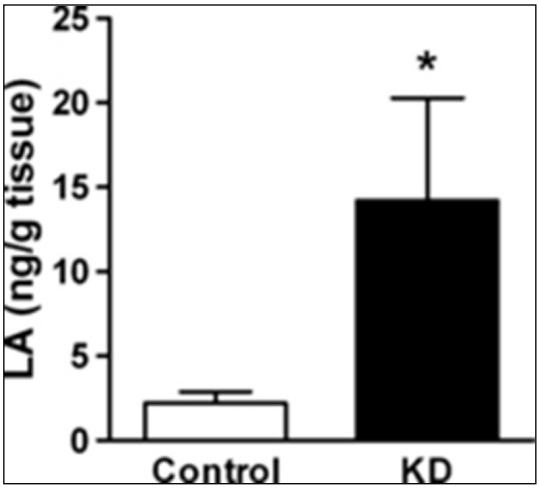


In Figure 1, three sets of bars (one black and one white per set) show the amount of damage sustained by mitochondrial DNA (mtDNA) following hydrogen peroxide (H2O2) exposure for 0, 15 and 30 minutes. The amount of mtDNA damage sustained by the non-ketogenic rats (the white bars) increased markedly with time, whereas the amount of mtDNA damage sustained by ketogenic rats (the black bars) was far lower. Surprisingly, mitochondrial damage slightly *decreased* between 15 and 30 minutes for ketogenic rats.

The Ketogenic Diet Also Increases Lipoic Acid Within the Hippocampus

This study also measured *lipoic acid*, another antioxidant produced within the hippocampus. Rats fed a ketogenic diet exhibited significant increases in lipoic acid (LA), as shown in Figure 2.

Figure 2



In Figure 2, rats fed a standard diet, (the control group—see the white bar), produced negligible amounts of lipoic acid within their hippocampal mitochondria. Impressively, rats fed a ketogenic diet produced significantly greater amounts of lipoic acid (LA) within their hippocampal mitochondria (black bar). By substantially increasing the production of glutathione and lipoic acid within the mitochondria of the hippocampus (as well as other antioxidants not shown in Figures 1 or 2), the ketogenic diet provides powerful protection against RONS in the brain.

The Ketogenic Diet and Neurological Issues

Several excerpts from a scientific article entitled *Ketogenic diets, mitochondria, and neurological diseases* follow. This article was published in the May 2014 edition of the *Journal of Lipid Research*. This journal article reviews the impressive benefits of the ketogenic diet on epilepsy, Parkinson's disease, Alzheimer's disease, brain cancer, amyotrophic lateral sclerosis (ALS), pain, inflammation and neurotrauma. In addition, the ketogenic diet has been strongly associated with improvements in many neurological deficits and diseases affecting the brain and its functions. The following quotes (the inset text) are taken directly from the same 2014 study[36]:

Epilepsy

> …it is known that a break from the [ketogenic] diet by ingestion of carbohydrates rapidly reverses the anti-seizure effects of the [ketogenic] diet. In fact, the onset of seizures can occur *less than an hour after administration of glucose*. [Italics mine.]

The above quote describes that the ingestion of carbohydrates reverses the anti-seizure effects of the ketogenic diet *within one hour*. I'm often asked about cheat days, i.e., days when one abandons the Metabolic Masterplan Diet and consumes carbs and sugars. The above quote, as well as many others in this book, is proof positive that when carbs and sugar are consumed, the far-reaching and urgently needed benefits of the ketogenic diet are lost—including protection against epileptic seizures. The following quote from this same study describes the beneficial effects of the ketogenic diet on seizures in children in cases where anti-seizure drugs are ineffective, a condition known as intractable epilepsy:

> In this randomized controlled trial of 145 children, aged 2–16 years old with daily seizures and who did not respond to at least two ASDs [anti-seizure drugs], it was shown that those who maintained the KD [ketogenic diet] for greater than three months had a significant reduction in the mean percentage of baseline seizures (2). Seven percent of children on the KD demonstrated a greater than 90% reduction in seizures, compared with 0% on the control diet, and there was a more than 50% reduction in seizures in 38% of the patients on the KD versus 6% on the control diet (2).

The ketogenic diet's ability to reduce epileptic seizures is quite impressive. The connection between epilepsy and the ketogenic diet is explored in greater detail later in this chapter. If you or anyone you know suffers from epilepsy, please tell them about the ketogenic diet's life-changing benefits.

Parkinson's Disease

Parkinson's disease is a progressive disorder in which a part of the brain, known as the *substantia nigra* is damaged, and dopamine levels are reduced. These changes result in many symptoms, e.g., tremors and impaired balance. Parkinson's disease, which James Parkinson described in 1817, is prevalent today, affecting roughly 10 million people worldwide. The following quote indicates that the ketogenic diet improves measurable outcomes in Parkinson's patients. These outcomes are measured using the Unified Parkinson's Disease Rating Scale:

> In PD [Parkinson's disease] patients treated with the KD [ketogenic diet] for 4 weeks, scores on the Unified Parkinson's Disease Rating Scale improved.

Research into the beneficial effects of the ketogenic diet on Parkinson's disease is still in progress. However, several studies demonstrate that the ketogenic diet improves involuntary tremors, memory, cognitive function, balance, walking and other vital outcomes in patients with Parkinson's disease[37,38,39,40].

Alzheimer's Disease

Alzheimer's disease is a widespread neurological disorder that progressively destroys key areas within the central nervous system. This destruction causes dementia; the symptoms of dementia include memory loss, behavior changes and the inability to care for oneself. Dr. Alois Alzheimer described Alzheimer's disease in 1910; since that time, Alzheimer's disease has become the most common form of dementia worldwide, affecting nearly 45 million people worldwide:

> In fasted patients with AD [Alzheimer's Disease] or mild cognitive impairment, acute ingestion of a MCT [medium chain triglyceride] drink increased BHB [beta-hydroxybutyrate, a ketone] levels and cognitive function compared with the placebo (151). Further, in a separate study of older adults with mild cognitive impairment, a low-carbohydrate (5–10% of calories) diet for 6 weeks enhanced a measure of verbal memory versus preintervention scores, whereas there was no change in those assigned to the high-carbohydrate (50% of calories) diet (152). Additionally, the improvement in memory in those on the low-carbohydrate diet was positively correlated with levels of urinary ketones (152). Finally, Henderson et al. (153) treated 152 patients having mild-to-moderate AD daily with 20 g of MCT for 3 months, and found that MCT-treated patients [lacking the apoE epsilon 4 (APOE4) allele] achieved significantly higher Alzheimer's Disease Assessment Scale-cognitive subscale scores at two different time-points versus placebo-treated controls. Interestingly, postdose serum BHB levels correlated positively with improvement in Alzheimer's Disease Assessment Scale-cognitive subscale scores.

As with Parkinson's disease, research into the beneficial effects of the ketogenic diet on Alzheimer's disease is still in its early stages. Various studies, however, describe that the ketogenic diet improves the symptoms of Alzheimer's disease[41, 42, 43]. Remarkably, simple dietary changes can improve outcomes in cases where neurological destruction *has already occurred*.

Brain Cancer

Various cancers affect the brain, including glioblastoma, astrocytoma, and oligodendroglioma. Brain cancers are highly dependent on blood sugar, making them uniquely susceptible to the ketogenic diet, which lowers circulating blood sugar:

> Because cancer cells preferentially use glucose for energy, and the KD [ketogenic diet] reduces glycolytic flux [the rate at which blood sugar is made] and enhances oxidative metabolism, high-fat KDs [ketogenic diets] may represent potentially viable treatments to limit oncogenesis [the creation of new cancers](161). Indeed, this conceptual approach was demonstrated in a compelling manner in a mouse astrocytoma [a type of brain cancer] model, indicating that plasma glucose [blood sugar] is an accurate predictor of tumor growth more than the specific origin of dietary calories.

In other words, because cancerous brain tumors prefer to create ATP from blood sugar, the ketogenic diet, which lowers blood sugar, is a viable treatment for brain cancer. This finding is described in other scientific studies[44], and has been shown to lengthen survival rates in cases of advanced central nervous system cancers[45].

Amyotrophic Lateral Sclerosis (ALS)

Amyotrophic Lateral Sclerosis (ALS) is a neurological disease characterized by the progressive degeneration of nerve cells in the spinal cord and brain. This degeneration is believed to be caused by extremely high levels of RONS, demonstrating the destructive power of free radicals. Commonly referred to as Lou Gehrig's disease, ALS causes various symptoms, ultimately resulting in death. The following quote states that the ketogenic diet improves ALS outcomes, a finding that has been corroborated by other scientific studies[46,47]:

> Mitochondrial dysfunction is also thought to contribute to the progression of ALS, a disease characterized by degeneration of motor neurons in the cortex [a part of the brain] and spinal cord (173). In ALS mice, the KD [ketogenic diet] improved motor function, as evidenced by increased time to failure on rotorod performance [a measure of strength and endurance] and this was associated with preservation of motor neurons in the ventral horn of the spinal cord (174).

Pain and Inflammation

Pain is a natural consequence of chronic inflammation, and chronic inflammation is rampant in the modern world. By reducing RONS in the mitochondria, the ketogenic diet reduces inflammation throughout the body, thus reducing pain. Other scientific studies have described the ketogenic diet's reduction of pain and chronic inflammation[48,49]. This study explains that the ketogenic diet reduces pain and inflammation:

> In juvenile and adult rats, the KD [ketogenic diet] reduced pain…and inflammation.

Neurotrauma (Traumatic Brain Injury)

A traumatic brain injury (TBI) results from a force to the head strong enough to impair neurological and cognitive function. The effects of a TBI can result in permanent disability, and have become a significant cause of health impairment and death in the modern world. It's thus good news that the ketogenic diet has been shown to improve the outcomes of TBI. The following quote states that the ketogenic diet, through multiple means, offers neuroprotective benefits and counters the damaging effects of a TBI. Many other scientific investigations have corroborated this[50,51,52]:

> In spite of the glycolytic restriction [reduced blood sugar] observed, the KD, through a multiplicity of other neuroprotective mechanisms, may counter the pathophysiological changes seen after traumatic brain injury (TBI). [Note the bias in favor of blood sugar.]

Summing Up the Above Science Article

The above quotes are excerpts from the same scientific article, *Ketogenic diets, mitochondria, and neurological diseases*, published in the *Journal of Lipid Research* in 2014[53]. Thousands and thousands of peer-review science articles about the incredible benefits of the ketogenic diet have been published in the years since this article was released. This article summarizes the positive effects of the ketogenic diet on various neurological issues, including epilepsy, Parkinson's disease, Alzheimer's disease, brain cancer, amyotrophic lateral sclerosis (ALS), pain and inflammation, and neurotrauma. We'll now focus on the many other diseases and health issues positively influenced by the ketogenic diet.

The Ketogenic Diet and Other Common Health Issues

In addition to the impressive health benefits generated by the ketogenic diet that were just reviewed, many other diseases and health issues are also improved by the ketogenic diet. These include outcomes regarding stroke, autism, fear, anxiety and stress, neurotransmitter function, cancer, obesity, biomarkers, NRF2 activation (described soon), type 2 diabetes, insulin resistance, polycystic ovarian syndrome (PCOS), acne, multiple sclerosis, and conditions of the heart and brain.

Stroke

Americans suffer approximately 795,000 strokes each year, of which 140,000 are fatal. Strokes account for 1 in 20 US deaths[54]. While little research has been performed to determine if the ketogenic diet reduces the incidence of strokes, emerging studies demonstrate that the ketogenic diet can reduce the risk of stroke[55,56], and improves the recovery from strokes[57,58]. Notably, simple dietary changes improve health outcomes—even when neurological damage has already occurred.

Autism

Autism Spectrum Disorder (ASD) is both a tragedy and an epidemic in the modern world. Its effects devastate the lives of millions of humans and place an enormous strain on families and social institutions. Considering that the ketogenic diet is renowned for its positive influence on neurological issues, it's no surprise that it's associated with improvements in autism spectrum disorders. Children in a study who were put on a modified gluten-free ketogenic diet that was supplemented with MCT oil (medium-chain triglyceride) demonstrated significant improvement in core autism features as assessed from the ADOS-2 (Autism Diagnostic Observation Schedule) after three months[59]. The positive effects of the ketogenic diet on ASD are beginning to emerge from numerous recent scientific studies[60,61].

Fear, Anxiety, and Post-Traumatic Stress Disorder (PTSD)

Impressively, the ketogenic diet has been shown to positively affect fear, anxiety and post-traumatic stress disorder (PTSD). A December 2018 science article published in *Frontiers in Aging Neuroscience* entitled *A Ketogenic Diet Improves Cognition and Has Biochemical Effects in Prefrontal Cortex That Are Dissociable From Hippocampus* demonstrated that ketones improve the performance of crucial brain centers. The ketogenic diet allowed cognitive tasks to be performed during stress, fear, or anxiety with greater ease and competence[62,63]. The following paragraph (which I've paraphrased for the sake of clarity) is a bit technical, but gives you a feel for how exactingly the scientific literature describes the effects of the ketogenic diet on things like brain function in aging populations:

Aging populations display a reduced ability to convert blood sugar into ATP in two key areas within the brain: the prefrontal cortex and the hippocampus. These brain centers are active during cognitive tasks and during times of stress, fear and anxiety[64,65]. Individuals with general anxiety disorder (GAD) and post-traumatic stress disorder (PTSD) demonstrate diminished activity in these key brain centers[66,67], making it difficult to appropriately respond to life's challenges in a constructive and proactive manner[68,69]. As populations age, the injection of glucose (blood sugar) directly into the prefrontal cortex and hippocampus improves brain function, but creates long-term health consequences in the process[70]. The injection of insulin in the brain impairs cognitive function and produces health consequences[71]. Ketones, however, improve cognition without side-effects[72,73].

The overarching point of the above paragraph is that as we age, it's challenging to get enough fuel into the brain, which impairs ATP production. In turn, decreased ATP production impairs cognitive function, especially during stress. For reasons that researchers are still deciphering, neurological performance is enhanced when ketones are metabolized. The same cannot be said for blood sugar, which creates long-term health consequences.

Neurotransmitters, Neurological Conditions and Neurological Diseases

Neurotransmitters are chemicals transmitted from one neuron to another, exerting powerful influences over consciousness and physiology in the process. This transmission occurs across the *synaptic gap* between the terminal end of one neuron and another neuron's receptor. There are two main types of neurotransmitters: *Type I and Type II*.

Type I Neurotransmitters Are Excitatory, Type II Are Inhibitory

Type I neurotransmitters transmit *excitatory* messages across the synaptic gap, and Type II neurotransmitters transmit *inhibitory* messages. Excitatory neurotransmitters lead to *action potentials*. Action potentials cause neurons to fire, which results in muscle contractions and other excitatory functions throughout the body. Conversely, inhibitory neurotransmitters (Type II) inhibit action potentials, calming the body and mind.

The Ketogenic Diet Balances Excitatory and Inhibitory Neurotransmitters

The ketogenic diet is *strongly* associated with normalizing excitatory and inhibitory neurotransmitters, especially *glutamate* and *GABA*. Glutamate, the most excitatory neurotransmitter, is also the most prevalent; GABA, the second most prevalent, exerts an inhibitory effect within the brain. Excess glutamate (excitatory) is associated with "noise" in neuronal circuitry, as well as what's described as *excitotoxicity*. GABA, on the other hand, has a calming effect on the brain, body and consciousness. The ketogenic diet optimizes how glutamate (an excitatory neurotransmitter) is processed within the brain, resulting in the enhanced conversion of glutamate into glutamine, and ultimately into the inhibitory (calming) neurotransmitter GABA.

One percent of the world's population suffers from epilepsy, and one-third of all people with epilepsy are resistant to currently available anti-epileptic drugs[74]. Of this population of drug-resistant epileptics, it's estimated that 40% of all pediatric sufferers of epilepsy experience relief when they follow the ketogenic diet[75,76]. Innumerable studies have concluded that excess glutamate (an excitatory Type I neurotransmitter) contributes to neurological maladies such as epilepsy and Alzheimer's. Many of these studies concur that the ketogenic diet's normalizing effects on glutamate and GABA partially contribute to these impressive benefits. Neurotransmitter imbalances are also associated with Parkinson's disease, Alzheimer's disease, depression, insomnia, Attention Deficit Hyperactivity Disorder (ADHD), anxiety, memory loss, dramatic changes in weight, and addictions.

Cancer

According to the National Cancer Institute, 1,735,350 new cancer cases were diagnosed in the US in 2018; 609,640 Americans died from cancer that year. Cancer is a devastating disease that's difficult to understand and treat. By reducing circulating blood sugar, the ketogenic diet *slows the progression* of many cancers. These include glioblastoma, a specific type of brain cancer, and prostate, colon, pancreatic and lung cancer[77,78,79,80]. It's crucial to distinguish between slowing cancer progression and curing cancer. The ketogenic diet slows the rate at which many cancers proliferate, which differs from curing cancer.

A crucial point is that it's a thousand times easier to prevent chronic diseases like cancer from developing than treating them once they do. The evidence is clear: making lifestyle interventions *before* chronic diseases develop improves all

measurable health outcomes and reduces the odds of developing chronic diseases like cancer. Cancer is a complex, multifactorial disease with numerous presentations. Once it develops, a ketogenic diet may help to slow its spread.

Obesity and Imbalances in Blood Chemistry (Biomarkers)

Obesity is one of the most pressing health concerns in the modern world, and is associated with severe health issues of every shape and kind. A 2018 meta-analysis [combining the results of many studies] found that when 23 controlled trials involving 1141 obese patients were reviewed, the ketogenic diet positively affected cardiovascular health[81]. Specifically, it was found that the ketogenic diet is associated with significant reductions in the following ***biomarkers***:

- Triglycerides (fat)
- Fasting blood sugar
- Glycated hemoglobin (measured in a hemoglobin A1c test)
- Insulin levels
- C-reactive protein (a marker of inflammation)
- Systolic and diastolic blood pressures
- Total body mass
- Abdominal circumference
- Significant increases in high-density lipoprotein (HDL) cholesterol, with no significant changes in low-density lipoprotein (LDL) cholesterol.

One of the most concerning and distressing things patients seek help with is the inability to lose weight and normalize their blood chemistries. (Blood chemistries, also called biomarkers, are reviewed later in this section.) Millions struggle with weight, blood sugar, triglyceride and cholesterol issues. Fascinatingly, losing weight and optimizing biomarkers is a common outcome of switching to the Metabolic Masterplan Diet. Considering how widespread these healthcare issues are, I've included another excerpt from a journal article entitled *Long-term effects of a ketogenic diet in obese patients*. This article was published in the journal *Clinical Cardiology* back in 2004. It's easy to think that this information is so new that the medical profession hasn't had a chance to respond to it, but the fact is that information such as this has been in print for a very long time:

> The data presented in the present study showed that a ketogenic diet acted as a natural therapy for weight reduction in obese patients. This is a unique study monitoring the effect of a ketogenic diet for 24 weeks. There was a significant decrease in the level of triglycerides, total cholesterol, LDL cholesterol and glucose, and a significant increase in the level of HDL cholesterol in the patients. The side effects of drugs commonly used for the reduction of body weight in such patients were not observed in patients who were on the ketogenic diet. Therefore, these results indicate that the administration of a ketogenic diet for a relatively long period of time is safe[82].

As we'll see as we make our way through the Metabolism Section, the ketogenic diet improves weight, triglycerides, cholesterol, blood sugar, insulin, inflammation and other measures of health more than anything else. The effects of a ketogenic diet, especially one as sophisticated as the Metabolic Masterplan Diet, are nothing short of miraculous, and I continue to be amazed at the difference it makes in the lives of so many. Let's look at more impressive benefits associated with the ketogenic diet.

Multiple Sclerosis

Multiple sclerosis (MS) is an autoimmune neurological disease in which the immune system attacks the protective covering of the brain and spinal cord. Interestingly, an imbalance in the microbes that populate the colon (the microbiota) is thought to be involved in the pathogenesis of MS. A 2017 study published in the journal *Frontiers in Microbiology* established that the ketogenic diet normalized the colonic microbiota. However, the study included too few participants and followed them over too short a time to determine if improvements in the microbiome improved the signs and symptoms of MS[83]. Regardless, I decided to mention this study here to introduce the complexities of healthcare in the modern world. In the not-too-distant past, suggesting that an imbalance of gut microbes partially causes a degenerative neurological condition that affects 1 million Americans would have been laughable. But today, serious scientific studies are uncovering such a link.

Heart and Brain Conditions

Cardiovascular disease is the leading cause of death in the US. Heart attacks and strokes result in diminished blood flow to the heart and brain, causing ischemic (damage caused by impaired blood flow) damage to these vital organs. When the heart and brain produce greater amounts of ATP from ketones, their metabolic efficiency increases, conveying cardioprotective and neuroprotective benefits to these organs. The simple act of burning ketones improves heart function and prevents damage and death of the heart muscle during times of diminished blood flow, such as a heart attack[84,85,86]. This mechanism also applies to stroke[87,88].

Studies demonstrate that rats placed on the ketogenic diet exhibit "a remarkable capacity to tolerate diminished blood flow to the heart without developing myocardial (heart muscle) damage[89]." Ketogenic rats and mice are shown to survive longer than non-ketogenic rats when oxygen is cut off to essential tissues, including the heart and brain. The ketogenic diet improves healing following traumatic events such as heart attacks and strokes in humans[90]. These studies demonstrate that the ketogenic diet is strongly cardio- and neuroprotective[91,92].

Cardio- and Neuroprotective Benefits of the Ketogenic Diet:

- Increased concentrations of mitochondria in the heart muscle
- Tolerance to reduced blood flow (ischemia) in the tissues, including the heart and brain
- Faster recovery of cardiac function following the re-establishment of blood flow during a heart attack

Type 2 Diabetes and Insulin Resistance

Insulin resistance and type 2 diabetes are among the world's most pressing—and avoidable—healthcare concerns today. Consequently, insulin resistance and type 2 diabetes are a major focus of the Metabolism Section. Suffice it to say that the Metabolic Masterplan Diet is synonymous with improving the outcomes of these modern healthcare issues—and even reversing them[93].

Polycystic Ovarian Syndrome (PCOS)

Polycystic ovarian syndrome (PCOS) affects 7% of adult women. It's characterized by the development of small cysts on one or both ovaries, an imbalance in key hormones such as testosterone, hair loss, thinning hair, facial hair growth, and weight gain. PCOS is the leading cause of infertility in women of reproductive age. Rather remarkably, the ketogenic diet improves PCOS outcomes, even allowing pregnancy in women previously unable to conceive[94,95].

Nrf2 Activation

Nrf2 is a genetic pathway that controls the production of antioxidants, e.g., glutathione, inside your cells. The ketogenic diet upregulates the Nrf2 pathway, increasing antioxidant production[96]. The Nrf2 pathway is reviewed in greater detail in the Detoxification Section.

Acne

Acne is the most common skin condition in the US, affecting approximately 50 million Americans. Although the data isn't yet conclusive, persuasive clinical evidence suggests that the ketogenic diet effectively reduces acne's severity and progression[97].

Benefits of the Ketogenic Diet, per Meta Analysis

A study published in the *Journal of Postgraduate Medicine* summarized the benefits of the ketogenic diet, and concluded that it's effective in the treatment and management of the following conditions and diseases:

Endocrine Disorders

- Diabetes
- Obesity
- Metabolic syndrome (covered later in this section)
- PCOS
- Congenital hyperinsulinism (excess insulin production)
- Nonalcoholic fatty liver disease (covered later in this section)

Neurological Disorders

- Intractable epilepsy (resistance to anti-epileptic drugs)
- Lennox-Gastaut syndrome (a severe form of epilepsy that develops in infancy or early childhood)
- Myoclonic-astatic epilepsy (a severe form of epilepsy that develops in infancy or early childhood)
- Parkinson's disease
- Alzheimer's disease
- Amyotrophic lateral sclerosis (ALS)
- Migraine/headache
- Narcolepsy (a sleep disorder)
- Depression
- Autism

Metabolic Disorders

- Glucose transporter type 1 deficiency (a disorder that interferes with the transport of blood sugar into the brain)
- Pyruvate dehydrogenase complex deficiency (a metabolic deficiency that leads to the buildup of lactic acid)
- Phosphofructokinase deficiency (a genetic mutation that interferes with the production of ATP from blood sugar)

Others

- Trauma and ischemia
- Cancer/malignancy

The Ketogenic Diet, Autophagy and mTOR

A point reviewed in the Core Essentials Section is that billions of cells are broken down each day to keep your body functioning optimally. This process, known as ***autophagy***, is an ancient evolutionary strategy for maintaining cellular homeostasis. To ensure proper cell function, damaged cellular components must be broken down and recycled. The accumulation of environmental wastes and pollution destroys the environment, and the accumulation of wastes within the cells likewise degrades cellular, tissue, organ and organism health. It thus makes sense that autophagy (aw-*TAUGH*-fuh-GEE), which is a fundamental process wherein cellular debris is removed from the cells, is associated with increased health and *longevity*, and that decreased autophagy leads to impaired cellular, tissue, organ and organism health, and reduces longevity[98,99,100].

Autophagy is a relatively new discovery, and studies are being performed to determine what upregulates and downregulates this important process. Given the myriad health benefits associated with the ketogenic diet, it's unsurprising that it has been shown to enhance autophagy[101,102,103,104]. However, the enhancement of autophagy has not been demonstrated with other diets. A key reason why this is so has to do with *insulin*.

Autophagy is regulated by what's known as the *mTOR signaling pathway;* this pathway consists of mTOR complex 1 (MTORC1) and mTOR complex 2 (MTORC2). In basic terms, MTORC1 is a chemical that functions like a sensor that measures many essential bodily substances. MTORC1 measures insulin, the metabolic by-products produced in the body when carbohydrates, fats and proteins are oxidized, cytokines (immune cells), and the chemicals involved in oxidative stress reactions in the body[105].

Once MTORC1 gathers all of its data, it sends out signals that have a powerful effect on all areas of your life and health. These signals regulate metabolic pathways (particularly how fats and ketones are metabolized in the mitochondria) and control how cells grow, proliferate and survive. Depending on the data that MTORC1 gathers, the signals it sends out can increase metabolic and overall health or trigger the onset of cancer, cardiovascular disease, diabetes and Alzheimer's Disease[106].

A crucial point to consider is that the signals MTORC1 sends out are strongly influenced by the amount of food you consume. Obesity is fast becoming the new normal in the US and many countries around the globe. The overconsumption of macronutrients (fat, protein and carbohydrates) destroys our health, and one way it does so is by

dysregulating MTORC1 signaling. The science is clear that overeating produces deleterious MTORC1 output, and calorie restriction improves MTORC1 signaling.

The old computer science term *garbage in and garbage out* can help us further understand how MTORC1 creates helpful or harmful signals. Just as a computer's output is a product of the integrity of its programming, MTORC1's output is a product of the types and amounts of food you consume and your overall state of health. A point we'll review in detail in this section is that insulin exerts powerful effects on cell growth. Bodybuilders rely on steroids to increase muscle mass, but they also inject insulin into their bodies to increase the flow of amino acids, fat and carbohydrates into their cells to bulk up.

One of the many chemicals that MTORC1 monitors is insulin. The Western diet straightaway leads to elevated insulin levels, and high insulin levels dysregulate MTORC1 signaling, increasing the likelihood of developing a bevy of serious diseases. The Metabolic Masterplan Diet has been meticulously created to ensure you consume just the right amount of protein and fat daily to optimize MTORC1 signaling and autophagy. The ketogenic diet isn't a green light to consume excess fat and protein, and MTORC1 signaling is one of many reasons why this is so.

Autophagy is commonly associated with intermittent fasting. Intermittent fasting is a pattern of eating wherein periods of fasting are interspersed within periods of eating. For example, if your last meal is 7 p.m. and you have breakfast at 9 o'clock the following morning, your intermittent fast lasts 14 hours. Since MTORC1 signaling is improved by limiting the amount of food you consume, intermittent fasting is associated with enhanced autophagy.

Intermittent fasting isn't per se a diet; it's intentionally restricting calories for a certain length of time. The fact that intermittent fasting enhances autophagy makes it an essential topic in any conversation about optimizing health and well-being. Still, there's a caveat: just because a person restricts calories for a while doesn't mean that the types and amounts of food they consume between periods of fasting will contribute to their overall health. Following up an intermittent fast with the overconsumption of macronutrients is akin to taking six steps forward and six-and-a-half steps backward.

Thus intermittent fasting holds a great deal of potential, but this potential is thwarted by the overconsumption of macronutrients *or* the consumption of an unhealthy combination of macronutrients, i.e., the simultaneous consumption of fat, carbohydrates, sugar and excess protein. This common combination of macronutrients is consumed when we have a hamburger, fries and a soft drink (or beer or wine), and is guaranteed to induce *metabolic mayhem* (*Healthy Past 100's* term for damaged metabolism).

Another crucial point we'll review throughout the Metabolism Section is that once metabolic mayhem develops, the liver commonly produces excess blood sugar. This process, known as *gluconeogenesis*, produces *significant blood sugar, even in a fasted state*. This means that even in a fasted state, metabolic mayhem can interfere with the potential benefits of intermittent fasting.

It's easy to get caught up in concepts like intermittent fasting, autophagy and MTORC1. However, the overarching point of this book is to focus on the Short List and make lifestyle interventions to optimize your health. It's imperative to take steps to enhance autophagy and MTORC1 signaling; to absolutely positively ensure that you're doing this, *focus on the Short List*. Intermittent fasting is helpful, but healing your metabolism and metabolizing fats and ketones enhances autophagy in the long run. Autophagy isn't per se a component of the Short List because it's an effect of various upstream causes. Focusing on the Short List will address the upstream causes that allow autophagy to naturally become optimized. When you do only what works, everything falls into place.

The Ketogenic Diet Improves Immune System Function

Humans spend billions and billions of dollars each year on products that promise to boost the function of the immune system. The immune system benefits from vitamin C, vitamin E and other essential nutrients, and it also benefits when your cells metabolize ketones. A study published in 2021 stated that ketones profoundly and markedly impact human T-cell responses. (T-cells are crucial in warding off pathogens, suppressing tumor growth and maintaining immunological memory.) this study stated that the ketogenic diet requires rethinking the value of nutrition and dietary interventions in modern medicine[107].

The Ketogenic Diet Is More Effective Than Low-Fat Diets for Weight Loss

There are many ways to lose weight, but the ketogenic diet is the best means of losing weight and keeping it off for good. According to Time Magazine, 49% of Americans tried to lose weight between 2013 and 2016[108]. However, in a recent meta-analysis of randomized controlled trials comparing the long-term effects (greater than one year) of dietary interventions, there was no sound evidence for the low-fat diet. Importantly, low-carb diets led to more significant weight loss than low-fat diets[109].

Who Should Avoid a Ketogenic Diet?

People who are experiencing pancreatitis, liver failure, disorders of fat metabolism, primary carnitine deficiency, carnitine palmitoyltransferase deficiency, carnitine translocase deficiency, porphyrias, or pyruvate kinase deficiency are advised to avoid a ketogenic diet unless under the supervision of a professional who's trained to treat these health issues[110]. As evidenced by thousands of peer-reviewed scientific articles, the ketogenic diet is safe for nearly everyone. Some people confuse the ketogenic diet with *ketoacidosis*, a life-threatening condition that develops as an end-stage complication of out-of-control diabetes[111]. The ketogenic diet is a specialized diet that prompts the liver to make ketones that nourish the body, whereas ketoacidosis is a last-ditch effort to keep the body alive by producing extremely high levels of ketones and blood sugar.

Summing up the Positive Effects of the Ketogenic Diet

If this is your first exposure to the ketogenic diet and its many impressive benefits, all of this can seem too good to be true. But, as mentioned in the first paragraph of this chapter, the highly impressive nature of the peer-reviewed scientific information about the ketogenic diet was the original impetus for this book. As I poured through study after study, I was struck by the remarkable benefits of the ketogenic diet. Even though I was hesitant to switch to a fat-based diet, the awe-inspiring benefits I was reading about helped me make the switch. Within a day, I was amazed. I felt alive, physically, psychologically and otherwise, none of which has waned since the middle of 2015. Personal anecdotes aside, the ketogenic diet is associated with a long list of health benefits, and improves an ever-growing list of diseases and health issues.

The Scientifically Proven Benefits of the Ketogenic Diet:

- The increased production of glutathione, lipoic acid and other antioxidants within key neurological centers
- Improvement in epilepsy outcomes
- Improvement in Parkinson's disease outcomes
- Improvement in Alzheimer's disease outcomes
- Improvement in brain cancer outcomes
- Improvement in amyotrophic lateral sclerosis outcomes
- Improvement in pain and inflammation outcomes
- Improvement in traumatic brain injury outcomes
- Improvement in stroke outcomes
- Improvement in autism outcomes
- Improvement in fear, anxiety and post-traumatic stress disorder (PTSD) outcomes
- Improvement in neurotransmitter balance and neurotransmitter-related diseases and conditions
- Improvement in obesity outcomes
- Improvement in biomarkers
- Improvement in multiple sclerosis outcomes
- Improvement in heart and brain conditions
- Improvement in type 2 diabetes outcomes
- Improvement in insulin resistance outcomes
- Improvement in polycystic ovarian syndrome (PCOS) outcomes
- Improvement in Nrf2 activation
- Improvement in acne outcomes
- Enhancement of autophagy and MTORC1 signaling

What's Next?

Now that we've reviewed the science supporting the ketogenic diet, we'll focus on the ins and outs of healing and optimizing your metabolism.

Chapter 3:
How Metabolic Energy (ATP) is Made

It's becoming clear that when ATP is created from fats and ketones, an impressive array of health benefits emerges from within your cells and permeates every aspect of your life. What's also becoming clear is that creating ATP from blood sugar commonly results in sickness and disease. Thus, health and illness emerge from the same cause: the fuel used to create ATP in the mitochondria. One fuel leads to miraculous health, the other to sickness and disease. *The fuel source your cells use to make ATP impacts your life more than any other factor*. That's why switching to the Metabolic Masterplan Diet is such a crucial lifestyle intervention.

ATP Is Made From Oxygen and Fuel

Throughout the rest of this section, we'll continue to deepen our understanding of why metabolizing fats and ketones rather than blood sugar is so important to your health. Let's begin this process by reviewing how ATP is created in the mitochondria. Creating ATP (adenosine triphosphate) requires a plentiful supply of oxygen. Humans require so much oxygen to make ATP that we breathe roughly 22,000 times daily, forcing 2,000 gallons of air through our lungs in the process. Ninety-eight percent of the oxygen we breathe is transported to the mitochondria, where it's used to make ATP[112].

The Breath of Life

If you hold your breath, your cells won't be able to make nearly as much ATP, and something will well up from deep inside your being and force you to take another breath. The reason is simple: without oxygen, there is no ATP, and without ATP, there is no life. Breathing. It's the first thing you do when you're born and the last thing you do when you leave this life, and it's all to supply oxygen to your mitochondria so they can create life-sustaining ATP. Life is inseparable from breathing, and life is inseparable from producing ATP. Life is much more than just ATP, but just the same, there's no biological life without it. Thus metabolism, which is the creation of ATP, is what sustains biological life in existence.

The Fuel of Life

To create ATP, we ceaselessly breathe in oxygen and transport it to the quasi-infinite number of mitochondria throughout the body. But that's only half of the story. To create ATP, it's also necessary to transport *metabolic fuel* to each and every mitochondria in the body. There are five types of metabolic fuel that humans can use to create ATP: fats, ketones, blood sugar, amino acids and alcohol. Just as gasoline, diesel and propane propel vehicles down the road, fats, ketones, blood sugar, amino acids and alcohol are the metabolic fuels that propel you down the road. (Although alcohol is converted into ATP, it's a health-destroying toxin that's best avoided.)

How Energy is Extracted From Metabolic Fuels to Create ATP

We learned earlier that in its *anionic form*, oxygen has a strong electronegative charge. This charge is so strong that it can break apart the chemical bonds that hold molecules together. The process wherein oxygen breaks apart chemical bonds is known as *oxidation*. When oxygen and metabolic fuels are transported into the mitochondria, oxygen breaks apart the chemical bonds that hold metabolic fuels together. When chemical bonds are broken (oxidized), energy is released. This energy is harnessed within the mitochondria and converted into vast numbers of ATP molecules. Thus ATP is a storage form of metabolic energy that's created when oxygen oxidizes the chemical bonds that hold metabolic fuels together.

Thus, metabolism is converting the energy stored within chemical bonds of metabolic fuels, e.g., fat, into ATP. We breathe air and consume food to create the form of metabolic energy (ATP) that our cells can utilize as fuel. *ATP is the only energy source that our cells can use.* Biological life is sustained by the ATP produced when metabolic fuels are oxidized within our cells' vast numbers of mitochondria.

The Types of Fuel That Can Be Used to Create ATP:

- Fats
- Ketones

- Blood sugar (glucose)
- Amino acids
- Alcohol (alcohol is converted into ATP, but is a toxin, not a fuel)

It's Super Cool to Use the Right Fuel

Now that we've reviewed how metabolic fuel is converted into ATP, let's reiterate a key point: the metabolic fuel your cells use to create ATP can make the difference between optimal health and sickness. The fact is that using blood sugar, amino acids (protein) and alcohol as metabolic fuels causes health issues and diseases, whereas metabolizing fats and ketones invoke mitohormesis. Mitohormesis produces more ATP, more antioxidants and fewer RONS within the mitochondria. Mitohormesis also initiates *mitochondrial biosynthesis*, i.e., the creation of more mitochondria in key areas of the body. When areas of the body that require more ATP can produce greater numbers of mitochondria, all health measures are improved.

The Four Components of Mitohormesis:

- The creation of more metabolic energy (ATP)
- The creation of more antioxidants
- The creation of fewer RONS (reactive oxygen and nitrogen species)
- The creation of greater numbers of mitochondria (mitochondrial biosynthesis)

We Make Lots and Lots of ATP

Humans store approximately 1 billion molecules of ATP *in each cell*. That's a lot of tiny molecules of ATP shoehorned into each cell! The human body consists of about 100 trillion cells. If you multiply 1 billion molecules of ATP times 100 trillion cells, the result is 10 23 (10 with 23 zeros). Even though we store vast numbers of ATP molecules in our cells, we burn through them in a minute or two when at rest, and during strenuous exercise in seconds. So whether we're sound asleep or pushing ourselves to the limit, each of our cells must be able to produce an abundance of ATP to keep us in a state of optimal health.

ATP is Energetic Currency

Scientists sometimes describe ATP as a form of *energetic currency*—something that can be created now and saved for future use, even if that future is just a few seconds or a fraction of a second away. Even when we're not very active, we create our body weight in ATP every day. The more active we are, the more ATP we create. Most ATP is consumed by your brain, liver, heart, kidneys and lungs[113]. Rather unceremoniously, we burn through the bulk of our ATP to pump sodium out of our cells and potassium into them. In addition to maintaining the balance of sodium and potassium within our cells, we have to think, breathe, digest, pump and filter our blood, and make the thousands of chemicals needed to keep our bodies alive, all of which require ATP.

We're Only as Healthy as Our Least-Healthy Cells

Each cell is tasked with making 100% of its own ATP. Therefore, ATP can't be transferred from cells that temporarily have a surplus to cells with trouble creating what they need. If some cells can't produce the required ATP, our overall health will spiral downward. We're only as healthy as our least-healthy cells, underscoring the importance of metabolic efficiency. The more efficiently your cells can produce ATP in each split-second of your incarnation, the greater your health becomes.

Metabolism Recap #2: ATP

If you're thinking, "Enough already with the ATP sledgehammer," smile and know that you're learning a great deal about the metabolic energy your cells create to keep themselves alive. Knowing the basics about how ATP is produced, what it's made from and why it's essential to your health allows you to understand why the foods you consume make such a difference in your overall health. Following are some critical points about ATP:

- Humans breathe air and consume food for the sole purpose of creating ATP.
- ATP is metabolic energy, i.e., the fuel that cells rely on to power their numerous functions.
- Vast quantities of ATP are required to power your body and keep you healthy.
- ATP is made from oxygen and metabolic fuel.

- ATP can be created from five metabolic fuels: fats, ketones, blood sugar, amino acids and alcohol.
- Fats and ketones are the most efficient metabolic fuels.
- Metabolizing fats and ketones in the mitochondria leads to mitohormesis.
- Mitohormesis produces greater amounts of ATP, fewer RONS and more antioxidants in the mitochondria.
- Mitohormesis also initiates mitochondrial biosynthesis, the creation of more mitochondria in key areas of the body.
- Producing ATP from fats and ketones is strongly associated with optimal health, whereas producing ATP from blood sugar (glucose), amino acids and alcohol is associated with various health issues and diseases.
- The ultimate purpose of metabolism is the production of metabolic energy (ATP) in the mitochondria.
- Even when you're inactive, you'll create your body weight in ATP to perform the essential life-sustaining functions that keep you alive and well.

Why Cutting Carbohydrates Doesn't Always Lead to Nutritional Ketosis

Now that we've reviewed the basics of metabolism and why it's so important to your life and health, we'll turn our attention to one of the most fundamental points of this book: how to switch to the Metabolic Masterplan Diet (MMD). The MMD has been painstakingly designed to heal and optimize your metabolism, thus unlocking the powerful health benefits of mitohormesis within your cells. The miracle breakthrough you're searching for is already inside you, waiting to be set free. So how do you set it free? By saying *goodbye* to sugar and carbohydrates and *hello* to fats and ketones.

A Word of Caution Before Switching to the Metabolic Masterplan Diet

When we follow the Western diet, our cells make virtually all of their ATP from blood sugar. Unfortunately, generating ATP from blood sugar commonly leads to metabolic damage, and this damage interferes with the ability to produce ATP from fats and ketones. It's thus imperative to heal metabolic damage *before* switching to a high-fat diet. This crucial point, which is built-in to the Metabolic Masterplan Diet, is reviewed in detail throughout the rest of this section.

The Journey to Miraculous Metabolism Begins by Cutting Carbohydrates and Sugar

Switching to the Metabolic Masterplan Diet and enjoying the powerful benefits of miraculous metabolism begins by strictly limiting your intake of carbohydrates and sugar. When the consumption of carbohydrates and sugars is kept to a bare minimum, and when protein is consumed in moderation (protein intake is reviewed in detail in the Core Essentials Section), a cascade of blood sugar and hormonal shifts cue the liver to produce an ample supply of ***ketones***.

When the liver begins producing ketones, virtually all your cells except red blood cells (they lack mitochondria and produce ATP through less efficient means) will start creating their ATP from ketones and fat[114]. This life-changing shift typically occurs within three days[115,116], which is the amount of time it takes the liver to achieve its maximum output of ketones[117]. As the liver pumps out an abundance of ketones, more and more of your cells rely on them to make the ATP they require[118,119,120,121]. When a significant percentage of your cells make ATP from ketones, a state referred to as ***nutritional ketosis*** develops[122].

The Central Nervous System Loves Ketones, the Body Loves Fat

For the first 21 days of nutritional ketosis, your liver will pump out more than enough ketones to power all of your cells. Curiously, however, after 21 days, the liver cuts back its production of ketones, and makes only enough of them to fuel your brain and spinal cord, i.e., the central nervous system (CNS)[123,124]. To ensure that ketones make their way to the CNS, the cells outside of the CNS burn increasing amounts of fat, safeguarding ketones for the brain and spinal cord[125,126].

Even though the liver significantly cuts back on its production of ketones, the CNS continues to derive approximately 75% of its energy from ketones *so long as a state of nutritional ketosis is maintained*[127,128,129,130,131,132]. This is crucial, because the central nervous system benefits in various ways when it metabolizes ketones. (This is why I don't recommend cheat days or cyclical keto diets, i.e., diets wherein you intentionally consume carbohydrates and sugar to leave a state of nutritional ketosis.)

As just described, when the liver reduces its production of ketones, the cells outside the CNS increasingly rely on fat to produce ATP. It was also mentioned that red blood cells, which lack mitochondria and a nucleus, produce ATP through less-efficient means. Cells with a nucleus are called eukaryotic (YOO-ker-*OT*-ic) cells. Research indicates that eukaryotic cells prefer fat and ketones as their primary fuel sources[133,134,135,136]. Even though the CNS will derive most of its energy from ketones, it will continue to meet some of its energy needs from blood sugar (glucose), as will some of the cells in the periphery of the body, especially during exercise. Blood sugar isn't a menace to be done away with, but it does need to be kept within healthy limits to ensure optimal health.

The Blood Brain Barrier and "Metabolic No Man's Land" a.k.a. Keto "Flu"

The central nervous system (CNS) is covered by a tough, multi-layered skin-like protective membrane known as the *blood-brain barrier (BBB),* a.k.a. the meninges. A healthy BBB is exceptionally selective about what passes through its channels and into the brain and spinal cord. The BBB is so selective that it won't allow blood sugar, ketones or triglycerides (a type of fat used as a metabolic fuel) to pass through its membrane channels without an escort. Talk about selective! Instead, these metabolic fuels are transported across the BBB via *transport molecules*.

Ketones are transported across the BBB via *monocarboxylate transporters*, and glucose is transported via *glucose transporters*. If you've been burning blood sugar for decades, your BBB will be used to shuttle plenty of blood sugar into your CNS via glucose transporters, but it may not have enough monocarboxylate transporters on hand to shuttle ketones into the CNS. When the liver begins flooding the body with ketones, the BBB increases its production of monocarboxylate transporters, but it can take 3-5 days to produce enough of them to supply the CNS with the ketones it requires to produce ample amounts of ATP.

Some people can rapidly create enough monocarboxylate transporters to ferry plenty of ketones into their CNS, but others aren't. Those who can immediately begin powering their CNS with ketones and notice no lack of energy as their body switches into a state of nutritional ketosis. Those less fortunate souls who cannot quickly make enough monocarboxylate transporters are likely to experience what I call ***metabolic no man's land***, or what's colloquially referred to as "keto flu."

Metabolic no man's land isn't the flu: the temporary lack of brain fuel happens as the CNS shifts away from relying on blood sugar as its primary metabolic fuel and switches over to ketones and fats. Unfortunately, if you find yourself in metabolic no man's land, there's not much you can do about it except wait it out. It generally takes 3-5 days for your body to create enough monocarboxylate transporters to supply the brain with ketones, after which the symptoms of metabolic no man's land will fade away. Metabolic no man's land isn't dangerous but can wipe you out for a few days.

Key Point: low blood sugar is only an issue if your brain and body rely on it to produce significant amounts of ATP. If your cells make most of their ATP from fats and ketones, your blood sugar levels will naturally remain low. No one who is glucose-adapted complains about having low blood ketone levels, just as no one who relies on fats and ketones to create ATP experiences low blood sugar. What's most important is having an ample supply of the metabolic fuel you depend on to make the bulk of your ATP.

The Brain Relies on Ketones and Fat to Produce ATP

Highly respected physiology textbooks, including those used in medical schools and other professional institutions, have long stated that the CNS is an "obligate glucose metabolizer," meaning it can only use blood sugar (glucose) to produce ATP. Textbooks have also long stated that fat doesn't cross the BBB, and therefore cannot be used by the CNS as a metabolic fuel. In truth, however, a healthy CNS is composed of significant amounts of fat, and produces roughly 20% of its energy from fats[137]. These myths originated in sugar industry propaganda from the 1950s, propaganda that's still alive and well today. Please refer to the Sugar Section for more information on the interesting history between the sugar industry and medicine.

Nutritional Ketosis Turns Your Fat Stores Into ATP

When you enter into a state of nutritional ketosis, a metabolic magic trick that billions of people are desperate to pull off occurs all by itself. What is this metabolic magic trick? It's when your fat stores effortlessly melt, shrink and fade away. Here's how it happens. When you enter into nutritional ketosis, your liver converts the fat stored throughout your body into ketones. There are no ketones in the food supply; the only way to get them in your body is to make

them from fat. (Crafty keto companies sell ketone supplements, but I recommend against them for various reasons we'll cover later in this book.)

If you've been desperately trying to lose weight but nothing has worked, get ready to do the happy dance to end all happy dances. When you limit your intake of carbohydrates, sugar and alcohol for three days and beyond, your liver will use the triglycerides (fat) that have been long-stored in your fat cells to produce ketones. When the liver produces ketones, many of your cells will also absorb triglycerides (fat) directly from your blood and use them to create ATP. Thus when you enter into a state of nutritional ketosis, your fat stores are converted into the ketones and triglycerides that your cells use to make the metabolic energy they require daily. This explains why people who remain on a ketogenic diet become and stay lean, but only if they're doing the ketogenic diet the right way. We'll return to this life-changing point over and over again throughout the Metabolism Section.

What in the World is a Carbohydrate, Anyway?

Carbohydrates are foods that become blood sugar (commonly called glucose or blood glucose) once consumed. Carbohydrates include sugar, fruits, potatoes, sweet potatoes, beans, grains, breads, cereals, pasta, noodles, granola, rice, popcorn, tortillas, crackers, polenta, oatmeal, gluten-free products and milk. Carbohydrates are commonly added to processed, low-fat and nonfat foods. Foods that contain carbohydrates are shown in Table 1.

Table 1: Carbohydrate-Rich Foods That Increase Blood Sugar

Sugar	Breads and flours	Grains, e.g., corn	Beans and legumes	Fruit
Sweets and candy	Starchy vegetables, e.g., potatoes, yams and beets	Soda and energy drinks	Juices	Rice, almond, oatmeal, soy and alternative milk products
Nuts (varies)	Seeds (varies)	Junk food	Milk*	Alcohol†
Pasta and noodles	Honey	Sweeteners and syrups	Baked goods, e.g., pie	Snack foods
Pancakes and waffles	Tortillas and pitas	Cereals	Muffins and bagels	Energy bars
Pretzels and crackers	Flavored yogurt	Processed foods	Condiments	Sauces

*Milk and milk-containing products are the only non-plant sources of carbohydrates.

†Alcohol isn't technically a carbohydrate, but your body processes it in the same manner as blood sugar. The more alcohol you consume, the more blood sugar you'll make. Some alcoholic beverages, e.g., beer, contain alcohol *and* carbohydrates and will likely kick you out of ketosis.

The Classifications of Carbohydrates

Carbohydrates are classified by their *molecular structure*. Some carbohydrates have *simple* molecular structures, and some have *complex* molecular structures. Those with simple structures are known as simple carbohydrates, and those with complex structures are called complex carbohydrates. Simple carbohydrates quickly become blood sugar once consumed, and complex carbohydrates increase blood sugar more slowly and over a longer time.

Classifications of Carbohydrates:

1. Simple carbohydrates, e.g., fructose, glucose and lactose
2. Complex carbohydrates (starches), e.g., potatoes, pasta, breads, cereals and grains
3. Sugars are a type of simple carbohydrates that readily become blood sugar once ingested
4. Starches are complex carbohydrates that raise blood sugar more slowly than simple carbohydrates
5. Fiber is a complex, indigestible carbohydrate that is important to gut health

The Many Types of Sugar in the Western Diet

The Western diet is high in sugar, including sucrose (table sugar), fructose (fruit sugar), maltodextrin and many other types of sugar. Sugar is any type of refined carbohydrate that is quickly converted to blood sugar once consumed.

Common Dietary Sugars Include:

- **Glucose:** found in honey, fruit (fresh and dried), grains, breads, cereals, pasta, rice, table sugar, condiments and sauces, soda, fruit juice, baked goods, processed foods, energy bars, salad dressings, vegetables and milk
- **Fructose:** found in dried fruit, fruit, syrups and sweeteners, condiments and sauces, cereals, processed foods, energy bars, salad dressings, pickles
- **Galactose:** found in honey, beets, cherries and products that contain milk
- **Sucrose:** (table sugar, which is glucose + fructose): found in many processed foods
- **Lactose:** (milk sugar, which is glucose + galactose): infant formulas, candies, eggnog, milk, low-fat dairy products
- **Maltose:** (malt sugar, which is glucose + glucose): found in breads and candies, energy bars, processed foods, baked goods, crackers, honey, frozen pizza
- **Maltodextrin:** a sugar made from vegetable starch used as a common food additive. Maltodextrin contains 4 calories per gram, the same amount as glucose and sucrose
- **High-fructose Corn Syrup:** made by extracting glucose from corn starch and converting some of the glucose into fructose. Please refer to the Sugar Section for more information on high-fructose corn syrup

Why Carbohydrates Interfere With Nutritional Ketosis

Carbohydrates interfere with nutritional ketosis because they increase blood sugar, and the body metabolizes blood sugar before fats and ketones. This is because even slight increases in blood sugar damage the body; to lower blood sugar, the body entices cells to absorb it. When cells absorb blood sugar, they use it as a metabolic fuel to produce ATP, which precludes the metabolism of fats and ketones. Therefore, the more carbohydrates consumed, the greater the blood sugar produced, and the greater the extent to which nutritional ketosis is thwarted.

Excess Protein and Alcohol Interfere With Nutritional Ketosis

It's not just sugar and carbs that will kick you out of ketosis: consuming more protein than your body needs also raises blood sugar levels, sometimes for several hours. Protein is made up of subunits known as amino acids. The body's ability to store amino acids is limited, and when this amount is eclipsed, some amino acids are converted into blood sugar.

Alcohol also stops the metabolism of fats and ketones in its tracks. Due to the highly toxic nature of alcohol, the body does everything it can to break it down and eliminate it from the body. One way that alcohol is eliminated from the body is by using it as a metabolic fuel to create ATP. Alcohol is broken down and metabolized in the mitochondria as a sugar, and sugars are always metabolized before fats and ketones. The following quote from *The Ketogenic Diet: A Complete Guide for the Dieter and Practitioner* describes the effects of alcohol and carbohydrates on nutritional ketosis:

> The consumption of alcohol will almost completely impair the body's use of fat for fuel. Similarly the consumption of carbohydrate affects the amount of fat used by the body for fuel. A high carbohydrate diet decreases the use of fat for fuel and vice versa[138,139].

Metabolism Recap #3: The Basics of Nutritional Ketosis

- Switching to the Metabolic Masterplan Diet begins by strictly limiting your intake of carbohydrates and sugar.
- When carbohydrate and sugar intake is strictly limited, the liver produces ketones.
- As the liver produces ketones, the body and brain begin using them to create ATP.
- This powerful metabolic shift, which ushers in a state known as nutritional ketosis, occurs within three days of limiting the intake of carbohydrates and sugar.

- Entering a state of nutritional ketosis also requires consuming moderate amounts of protein and avoiding alcohol consumption.
- After 21 days of nutritional ketosis, the liver significantly cuts back its production of ketones, making only enough to power the central nervous system.
- When this shift occurs, the cells outside the brain and spinal cord begin making most of their ATP from fats.
- It can take the body 3-5 days to create enough monocarboxylate transporters to shuttle an ample supply of ketones across the blood-brain barrier (BBB).
- If your body doesn't have enough monocarboxylate transporters, your brain may be unable to make enough ATP for a few days, resulting in metabolic no man's land, a.k.a. keto flu.
- This state isn't harmful but can leave you tired and worn out for a few days.
- Your blood sugar levels will drop when your body shifts into nutritional ketosis. This isn't harmful, because in a state of nutritional ketosis, your cells require significantly less blood sugar.
- In a state of nutritional ketosis, your central nervous system also utilizes fat as a metabolic fuel.
- In a state of nutritional ketosis, the majority of your cells begin using the fat that's been long-stored throughout your body to create ATP.
- Carbohydrates are foods that become blood sugar once ingested.
- Simple carbohydrates increase blood sugar quickly, and complex carbohydrates raise blood sugar more slowly over extended periods.
- The Western diet contains several types of sugar, all of which increase blood sugar.
- Since carbohydrates are utilized as metabolic fuel preferentially over fats and ketones, they interfere with nutritional ketosis.

What's Next?

Now that we've introduced the basics of switching to the Metabolic Masterplan Diet, we'll focus on one of the core concepts this book is based on: ***metabolic mayhem***. Metabolic mayhem is *HP100's* term for the damaging effects the Western diet has on your metabolism. This damage interferes with your ability to use fats and ketones to create ATP, making losing weight a difficult and even impossible undertaking. Therefore, metabolic mayhem absolutely positively must be healed before switching to the Metabolic Masterplan Diet.

Chapter 4:
Metabolic Mayhem Stops Nutritional Ketosis in its Tracks

It's supposed to be easy. The prevailing wisdom in keto blogs, books and websites optimistically states that all you have to do is cut your intake of carbohydrates to less than 50 grams per day (some say 100 grams), and you'll magically begin making ATP from fats and ketones. That's how it's *supposed* to happen. But once metabolic mayhem develops, reducing your intake of carbohydrates to 50 grams per day—or eliminating carbohydrates entirely—will not put you into a state of nutritional ketosis, even if you avoid carbohydrates and sugar for years.

Metabolic Mayhem is Very, Very Common

This scenario is so common that most patients I've worked with cannot enter into a state of nutritional ketosis simply by cutting back on carbohydrates and sugar. To understand why this is so and to develop the understanding required to turn this situation around, let's review a point from earlier in this section: when you strictly limit your intake of carbohydrates and sugars, consume only moderate protein and abstain from alcohol, your liver begins to produce enough ketones to power your body within three days. Your cells then begin creating ATP from the ketones your liver produces, ushering in a state of nutritional ketosis.

Metabolic Mayhem Stops Fat Burning in its Tracks

The above-described transition to nutritional ketosis *only occurs if your metabolism is healthy*. But if metabolic mayhem has taken root, your liver won't be able to produce enough ketones to allow your body to shift into a state of nutritional ketosis. Once metabolic mayhem becomes advanced, blood sugar is the only fuel your cells can use to produce the bulk of their ATP. This means that even if you're carrying around excess fat you're desperate to get rid of, your cells can't tap into it and burn it once metabolic mayhem becomes advanced. To understand why this is so, let's introduce one of the essential concepts of this entire book: *gluconeogenesis*.

Gluconeogenesis: Your Liver Is a Blood Sugar Factory

Through a critical process known as ***gluconeogenesis*** (*glue*-co-knee-oh-*JEN*-eh-sis), your liver manufactures blood sugar every second of your life. Just as consuming sugar and carbohydrates increases your blood sugar, the blood sugar your liver produces also causes your blood sugar to rise. Your liver produces blood sugar even when your cells burn fats and ketones. A *lot* of blood sugar. Your liver, via gluconeogenesis, makes far more blood sugar than you could possibly consume, even on your most indulgent cheat day.

Let's use *fasting blood sugar* to illustrate the point of gluconeogenesis. Fasting blood sugar is the amount of sugar dissolved in your blood when you haven't eaten for at least eight hours. If it's been eight or more hours since you last ate—even if you gorged on sugar and carbohydrates—all of the blood sugar extracted from your most-recent meal is long gone from your body. This means that the blood sugar measured on a fasting blood sugar test was made by your liver. So even if you fast for a week, you'll have sugar in your blood, and that sugar is created by the liver via a process known as gluconeogenesis.

Uncontrolled Gluconeogenesis: The Real Cause of Metabolic Mayhem

When your metabolism is healthy, your liver makes just the right amount of blood sugar to nourish the glucose-dependent cells in your body (predominantly red blood cells). But when metabolic mayhem sets in, your liver produces more blood sugar than your glucose-dependent cells require, *and it does so every second of the day*. As metabolic mayhem progressively worsens, the liver can create so much excess blood sugar that it's as though you're eating candy bars all day long, even if you haven't had sugar for years. Moreover, when blood sugar remains high around the clock, your cells use virtually no ketones or fat to create ATP, and your fat stores grow instead of shrink.

What Causes Excess Gluconeogenesis?

The fundamental question is, "What would cause the liver to produce too much blood sugar?" The answer to this question is *the Western diet.* The Western diet contains copious amounts of carbohydrates and sugar; most modern humans consume carbohydrates and sugar at every meal, including between-meal snacks. Thus the Western diet drives blood sugar skyward several times a day, causing gluconeogenesis to gradually spin out of control.

Metabolic Mayhem Underlies all Blood Sugar Problems

Health issues that cause blood sugar to rise were once rare, but have become among the most common and pressing health concerns that modern humans face. Health issues directly linked to excess blood sugar include insulin resistance, prediabetes, type 2 diabetes, obesity, metabolic syndrome and non-alcoholic fatty liver disease (NAFLD). (Type 1 diabetes also causes blood sugar dysregulation, but is caused by autoimmune destruction of insulin-producing cells in the pancreas.)

Metabolic Mayhem Explains How Metabolism Becomes Damaged

These health issues involve the overproduction of blood sugar, but none adequately describe how the Western diet damages the body and causes the liver to produce excess blood sugar. As a result, *HP100* uses the term *metabolic mayhem* to describe this damage. The concept of metabolic mayhem connects all the dots. It fills in all the puzzle pieces to provide an accurate picture of what happens in your body when the Western diet damages your metabolism and your liver produces excess blood sugar.

Metabolic Mayhem Explains How to Heal Your Metabolism

When you don't know what's actually taking place within your body, it's impossible to make the lifestyle interventions required to heal it. When you don't know what changes are necessary, your health gradually worsens, and your health issues become increasingly severe, even life-threatening. By comprehensively describing the damage caused by the Western diet, the concept of metabolic mayhem makes it possible to know precisely what steps to take to heal your body and keep it in optimal health for decades to come. This will become our focus in the coming chapters.

The Components of Metabolic Mayhem

We're still in the process of introducing metabolic mayhem, and many of the concepts central to it have yet to be reviewed. By the time you've finished reading this section, you'll understand the components of Metabolic Mayhem and what they mean to your health. For now, get a sense of these components, and we'll fill in the gaps as we go.

Metabolic Mayhem Includes These Components:

- Excess gluconeogenesis (blood sugar produced by the liver)
- Insulin resistance (when your cells become less responsive to insulin)
- Prediabetes or type 2 diabetes
- Imbalanced counterregulatory hormones (glucagon, adrenaline, noradrenaline, cortisol and growth hormone)
- Excess VAT (visceral adipose tissue)
- Obesity or overweight
- Chronic inflammation
- Cholesterol dysregulation
- Elevated triglycerides
- The diminished capacity or inability to metabolize fats and ketones
- Blood sugar dysregulation
- Elevated A1c test
- Constantly replenished glycogen stores
- Increased production of RONS (reactive oxygen and nitrogen species)
- Decreased production of ATP
- Atherosclerosis
- Sarcobesity
- Ectopic fat accumulation
- Excess de novo lipogenesis
- Adiponectin dysregulation
- Leptin dysregulation

Chapter 5:
Insulin and Insulin Resistance

Insulin

Insulin is a powerful hormone whose primary job is to reduce blood sugar. When we consume foods that increase blood sugar (carbohydrates, sugar, excess protein and alcohol), the pancreas secretes insulin to keep blood sugar levels from climbing too high. Insulin lowers blood sugar in various ways, the most powerful of which is by putting the brakes on gluconeogenesis, i.e., the liver's production of blood sugar.

Since the mid-1800s, the Western diet has been increasingly centered around carbohydrate-rich foods and sugar. As a result, modern humans consume carbohydrates and sugar throughout the day, which in turn causes blood sugar to rise repeatedly throughout the day. As blood sugar levels rise, the pancreas secretes insulin, which returns blood sugar to healthy levels. But when carbohydrates and sugar are consumed throughout the day for years, the endless up-and-down cycling of blood sugar and insulin makes it more and more difficult for insulin to fine-tune the amount of blood sugar the liver creates. This is known as ***insulin resistance***.

Insulin Resistance

When blood sugar and insulin endlessly rise and fall year after year, they gradually begin cycling through higher highs and lower lows. When the amplitude of these highs and low lows eclipse a certain threshold (which varies from person to person), the liver has difficulty cutting back its blood sugar production in response to small releases of insulin from the pancreas. This results in increased gluconeogenic output, and blood sugar levels increase 24 hours a day.

The pancreas responds to the liver's ratcheting up of blood sugar production by secreting more and more insulin. This works for a while, but as more and more insulin is secreted throughout the day and night, the liver becomes desensitized to insulin and continues producing excess blood sugar. The pancreas responds by creating even more insulin, and at a certain point, the constant barrage of insulin becomes so familiar that it's dismissed as background noise and ignored.

Signaling: How Cells Talk to Each Other

The concept of *impaired signaling* can help us understand how insulin resistance progresses. For example, if the signal your car radio picks up fades in and out, that's a signaling issue. The same happens when cell phones and internet devices cannot sustain uninterrupted connections. Signaling issues occur when the *receiver* (e.g., cell phone, radio, computer or a cell within the body) can't continuously receive the *broadcast* (information-containing signal) and follow its directions.

Cells communicate via *chemical signaling*. For example, when the pancreas secretes more and more insulin (a chemical signal released into the blood), it alerts the cells to perform specific actions. As circulating insulin levels progressively increase, insulin's signal becomes louder, and the cells pay more attention to its directives. But after a while, the cells get so used to bathing in insulin that instead of responding to it more, they become desensitized to it and tune it out, much like we tune out the background noise that we're routinely exposed to. When the body's cells stop paying close attention to insulin—especially when the *liver* pays less attention to insulin, *insulin resistance is developing*. The CDC (Centers for Disease Control) estimates that a whopping *1/3 of all Americans* are insulin resistant[140,141].

Insulin Resistance Progresses in Three Phases

Insulin resistance develops in three distinct phases. The first phase occurs when the liver becomes resistant to insulin's effects, producing more blood sugar than the body can utilize at the present moment. Then, as the pancreas secretes ever-greater amounts of insulin, the second phase of insulin resistance develops. In this phase, the skeletal muscles become resistant to the effects of insulin.

As skeletal muscles become insulin resistant, they can less absorb and utilize blood sugar. This is crucial because skeletal muscles consume significant blood sugar, even if you primarily burn fats and ketones. When skeletal muscles

can't efficiently absorb blood sugar, they can't create the ATP they require. This leaves you feeling worn out, tired, zapped of energy and too weak to do what you used to do with grace and ease. Furthermore, insulin resistance of the skeletal muscles leads to chronically elevated blood sugar levels, strongly contributing to obesity and type 2 diabetes.

The third phase of insulin resistance affects fat cells, known as *adipocytes*. Unlike the liver and skeletal muscles, which become less sensitive to insulin, adipocytes become *more* sensitive to the effects of insulin. This causes fat cells to absorb more blood sugar. As insulin and blood sugar levels rise, fat cells increasingly absorb blood sugar, your muscles make less ATP, and you become heavier and heavier. Such are the dynamics of insulin resistance.

The 3 Phases of Insulin Resistance:

1. The Liver becomes less sensitive to insulin and makes more blood sugar
2. Skeletal muscles become less sensitive to insulin, absorb less blood sugar and make less ATP
3. Fat cells (adipocytes) become more sensitive to insulin and absorb more blood sugar, thus increasing in size

There are Two Types of Insulin Secretions: Basal and Bolus

Insulin is secreted by the beta cells (β-cells) of the pancreas in response to the consumption of carbohydrates, sugar, and to a lesser extent, protein. Beta cells are located within a part of the pancreas known as the *islets of Langerhans*. Beta cells secrete insulin in two distinct ways: *basal* and *bolus insulin* secretions. *Basal insulin* is like a drip system that constantly pulses a small amount of insulin into the blood. *Bolus insulin* is a much larger insulin release secreted following meals containing carbohydrates, sugar or protein.

As insulin resistance progressively worsens, basal insulin—the insulin that's constantly dripped into circulation between meals—becomes excessive. Insulin resistance also leads to the overproduction of bolus insulin—the insulin secreted following meals. Insulin resistance can cause the pancreas to *substantially* overproduce bolus insulin, even when meals contain little or no carbohydrate.

The Two Phases of Bolus Insulin Secretion

Bolus (post-meal) insulin is secreted in two phases. First-phase bolus insulin response begins within a few minutes of eating and peaks in about 15-30 minutes, depending on how well your body dealt with the blood sugar consumed in the day's *previous* meals. If the first-phase bolus insulin response can lower blood sugar levels to healthy levels (between 70-100 mg/dl within 15-30 minutes), the second phase of bolus insulin response will be negligible. This is optimal bolus insulin secretion.

However, suppose the first phase of bolus insulin secretion cannot reduce blood sugar to between 70-100 mg/dl, i.e., *normoglycemia* (a normal level of blood sugar). In that case, second-phase bolus insulin secretion will occur repeatedly in an attempt to accomplish normoglycemia. If the first phase can't do it, the second will keep trying and trying until it (hopefully) succeeds. When the second-phase bolus insulin response has to repeat and repeat, insulin resistance or prediabetes is advancing, and type 2 diabetes may be right around the corner.

The Progression of Insulin Resistance to Prediabetes to Type 2 Diabetes

A hallmark of insulin resistance is elevated insulin levels, referred to as *hyperinsulinemia*. Hyperinsulinemia is associated with many health conditions and diseases, including type 2 diabetes and obesity[142]. Of grave concern is that hyperinsulinemia is associated with decreased lifespan[143] and increased cancer mortality, cardiovascular disease mortality, and all-cause mortality[144].

Once insulin resistance develops, the pancreas is tasked with producing significant amounts of insulin—for life. In some cases, the pancreas can indefinitely produce large quantities of insulin, but in other cases, the pancreas becomes fatigued, and insulin production decreases. This is prediabetes. Prediabetes is commonly diagnosed when fasting blood sugar is 100 to 125 mg/dL and hemoglobin A1c test results are 5.7-6.4%. If insulin production decreases to the point that fasting blood sugar readings rise above 126 mg/dL and hemoglobin A1c test results rise above 6.5%, type 2 diabetes is diagnosed. Blood sugar readings and the hemoglobin A1c test are reviewed in detail later in this section.

Insulin resistance, prediabetes and type 2 diabetes are devastating health issues *that are almost entirely preventable when lifestyle modifications are made*. Once rare, these blood sugar issues have become exceedingly common in the US and other industrialized nations, and are inextricably linked to the Western diet. Insulin resistance, prediabetes and type 2 diabetes are different expressions of metabolic mayhem, and must be healed—not managed—for lasting health improvements to occur.

Insulin Resistance: Why We Get Fat Without Overeating

An important point we're learning is that the liver produces blood sugar every second of the day to provide metabolic fuel to cells that lack mitochondria (primarily red blood cells). The constant cycling of blood sugar and insulin, which results from consuming carbohydrates and sugar throughout the day, gradually leads to insulin resistance. In the first phase of insulin resistance, the liver pays less attention to small insulin secretions, resulting in excess gluconeogenesis. As blood sugar levels progressively increase, the body's cells absorb as much of it as possible and use it to make ATP. When the body's cells have all the blood sugar they need, and the liver continues to produce greater and greater amounts of blood sugar, fat cells (adipocytes) absorb as much blood sugar as possible to keep blood sugar levels healthy.

If adipocytes cannot absorb enough blood sugar to keep it within healthy limits, the liver will convert excess blood sugar—*the very blood sugar it created via gluconeogenesis*—into fat. (Converting excess blood sugar into fat is known as de novo lipogenesis, and is reviewed in detail later in the Metabolism Section.) This fat, which is referred to as *triglycerides*, is packaged into tiny boats by the liver and dropped into the blood. These boats circulate through the body, looking for cells that can absorb triglycerides that can be used to create ATP.

This is where huge problems develop. Recall that the cells *always* absorb blood sugar to create ATP before they absorb triglycerides. Given that the liver is already producing more blood sugar than the cells can use, their capacity to absorb triglycerides is greatly impaired. This causes triglyceride levels in the blood to rise, and adipocytes (fat cells) are the only cells that can absorb them. Thus the fat cells, which are already full from absorbing blood sugar, are also tasked with absorbing the triglycerides the liver produces from excess blood sugar. If adipocytes can absorb these triglycerides, the fat in your blood will remain within healthy levels. But if the adipocytes can't absorb enough fat, triglyceride levels will increase to unhealthy levels.

This is how metabolic mayhem leads to high blood sugar *and* triglyceride levels. As metabolic mayhem progressively worsens, the liver can make so much blood sugar and fat—with the adipocytes absorbing both around the clock—that it's surprisingly easy to gain weight and become obese without overeating. Many patients I've worked with have been so insulin resistant that they couldn't lose weight, even when their caloric intake consistently remained around 900-1,000 calories daily. Fortunately, metabolic mayhem can be healed when the proper steps are taken. The combination of elevated blood sugar and triglycerides is a serious health issue that must be dealt with to avoid the risk of cardiovascular disease, diabetes, obesity, Alzheimer's disease and many other health issues. These topics are explored in greater detail in the coming chapters and the Cholesterol Section.

Insulin Resistance Turns Your Muscles Into Fat

When insulin resistance progresses to the point that the liver produces excess blood sugar, it must have some raw material to make blood sugar. The liver's preferred material is already in your body: ***amino acids***. Amino acids are the building blocks that create protein, which is what your muscles are made of. The liver stores a small number of amino acids in what's known as the ***amino acid pool***. However, these stores are too limited and tightly regulated to supply the amino acids the liver requires to produce more and more blood sugar throughout the day[145].

When insulin resistance advances, the liver requires a constant source of amino acids to produce blood sugar. Since the amino acid pool is too limited to supply the liver with what it needs, the body taps into its biggest reservoir of amino acids: *skeletal muscle*. Skeletal muscle consists of amino acids, and the body initiates the breakdown of its muscles to provide the liver with the raw material it requires to make increasingly greater amounts of blood sugar.

This is known as ***sarcobesity***, a condition that results in a net loss of lean muscle mass and a net gain in fat stores. Sarcobesity prioritizes the scavenging of lean muscle mass to such an extent that it's as if you're following a low-protein diet, even if you consume ample protein. However, as we'll see in the Core Essentials Section on protein,

chowing down on a bunch of protein will only worsen matters. Fortunately, the ketogenic diet reverses sarcobesity and increases skeletal muscle into advanced age[146].

Fat Doesn't Cause Obesity and Blood Sugar Problems, Sugar and Carbs Do

The point is becoming abundantly clear: we don't get fat from eating fat; we get fat from eating carbohydrates and sugar. The constant cycling of blood sugar and insulin leads to metabolic mayhem, the outcome of which is obesity and blood sugar dysregulation. When metabolic mayhem eclipses a certain threshold, the body becomes increasingly reliant on blood sugar as its only metabolic fuel, effectively stopping fat burning in its tracks. This is why, try as we may, losing weight becomes next to impossible once metabolic mayhem takes hold.

Metabolic Mayhem Must be Healed Before Switching to the Metabolic Masterplan Diet

For the many reasons just reviewed, it's imperative to heal metabolic mayhem before switching to any fat-centric diet. If you begin consuming large amounts of fat when your liver is overproducing blood sugar, the fat will get stuffed into your fat cells, making you sicker than you already are. Metabolic mayhem results from the carbohydrate-based Western diet, and the only way to heal it is by eliminating carbohydrates and sugar (and excess protein and alcohol) from your diet. This isn't opinion, it's fact.

Don't I Have to Be Overweight to Be Insulin Resistant?

A common misconception is that to be insulin resistant, prediabetic or diabetic, you must be overweight. While obesity and insulin resistance often go hand in hand, many normal-weight people are insulin resistant. Insulin resistance affects each of us differently. More often than not, insulin resistance attends being overweight or obese, but the CDC estimates that 12% of Americans with insulin resistance aren't overweight[147,148].

Fine Tuning Your Basal and Bolus Insulin if You're Diabetic

If you're type 1 or type 2 diabetic, it's necessary to supplement with basal and bolus insulin to keep your metabolism healthy. If you're switching to a fat-based diet, you'll most likely find that the amount of basal and bolus insulin required to maintain healthy blood sugar levels is lower—perhaps significantly lower—than when your cells relied on glucose to produce the bulk of their ATP. Through careful trial and error, you'll be able to fine-tune your basal and bolus insulin secretions, but only after metabolic mayhem has been healed.

Recap of Gluconeogenesis, Insulin and Insulin Resistance

When we ingest carbs morning, noon and night, insulin levels endlessly spike and plunge, and the liver must constantly start and stop blood sugar production. As this process plays out thousands and thousands of times, the connection between the liver and pancreas becomes strained. As this connection deteriorates, insulin resistance develops, and blood sugar production becomes untethered from the effects of insulin. This can be a gradual untethering, or it can happen quite suddenly.

Once sugar makes its way into the blood—whether it was ingested or created by the liver—it must be dealt with ASAP. If the body's cells don't need blood sugar, they soak up what they can, *and the rest of the sugar is converted to fat*. If you wolf down a pound of sugar, 99% of it will be converted to fat, because the body can only utilize small amounts of blood sugar at any given time. All excess blood sugar is destined to find its way to the unsuspecting hips, thighs, bellies and buttocks of those who fall prey to its evil ways.

Metabolism Recap #4: Insulin, Insulin Resistance and Gluconeogenesis

- Insulin is a powerful hormone whose primary job is to reduce blood sugar.
- The Western diet is characterized by several high-carbohydrate and sugar-containing meals each day.
- Consuming carbohydrates and sugar throughout the day causes blood sugar and insulin swings.
- This cycle of rising and falling blood sugar and insulin causes insulin resistance.
- As insulin resistance becomes excessive, lean muscle mass is scavenged and converted into blood sugar.
- This leads to sarcobesity.
- In sarcobesity, your muscles become smaller, but your body becomes larger.

- The ketogenic diet reverses sarcobesity and increases the size of skeletal muscles into advanced age.
- Insulin resistance progresses into prediabetes, which can progress into type 2 diabetes.
- Type 2 diabetes ensues when the pancreas can no longer create enough insulin to control gluconeogenesis.
- Blood sugar issues are always insulin issues in disguise.
- Insulin resistance and prediabetes are insulin signaling issues.
- The CDC estimates that 80 million Americans are insulin resistant.
- Insulin is secreted in two distinct ways: basal and bolus.
- Basal insulin is like a drip system that constantly pulses a small amount of insulin into circulation.
- Bolus insulin is secreted following meals, especially when carbohydrates, sugar and excess protein are consumed.
- Bolus insulin secretion repeatedly occurs until blood sugar is returned to normal levels.
- A high-carbohydrate diet causes both basal and bolus insulin secretions to increase.
- The excess blood sugar produced by gluconeogenesis is converted to fat.
- As insulin resistance sets in, losing weight becomes impossible unless metabolic mayhem heals.
- As gluconeogenesis and insulin resistance progressively worsen, fat cells become more sensitive to insulin.
- As fat cells (adipocytes) become more sensitive to insulin, they absorb more and more blood sugar.
- As fat cells absorb more and more blood sugar, obesity results.
- When blood sugar and insulin remain chronically elevated, burning fat becomes increasingly impossible.
- This is why it's possible to become and remain obese without overeating once insulin resistance develops.
- Fatigue sets in as the muscles become insulin resistant and have difficulty absorbing glucose.

What's Next?

Now that we've reviewed gluconeogenesis, metabolic mayhem, insulin and insulin resistance, we'll focus on a vital subject: how blood sugar is regulated within your body.

Chapter 6:
The Human Body Is Designed to Raise Blood Sugar, Not Lower It

Humans Have Five Hormones to Raise Blood Sugar and Only One to Lower it

High blood sugar is the scourge of the modern world, but it wasn't always this way. Until quite recently, pre-Western diets and an inconsistent food supply made *raising* blood sugar humanity's most pressing survival need[149]. But as the food supply became increasingly industrialized and more carbohydrates were incorporated into the human diet, modern humans suddenly found that *lowering* blood sugar was essential to survival.

This switcheroo was one of the most momentous events in Western history, though virtually no one knows that it even took place. This physiological shift is monumental because since humans appeared on the planet roughly two million years ago, our survival has hinged on *raising*, not lowering blood sugar. In the blink of a cosmic eye, however, the Western diet has changed so dramatically that the human species must *lower* blood sugar to survive, and we're hormonally wired to do exactly the opposite.

Insulin Counterregulatory Hormones: Raising Blood Sugar for Two Million Years

Now that we've spent considerable time learning about the lone hormone that lowers blood sugar (insulin), let's get up to speed on the five hormones that raise it. The five hormones that increase blood sugar are collectively known as ***counterregulatory hormones*** or *insulin counterregulatory hormones*. Given that "insulin counterregulatory hormones" is a mouthful to say, we'll refer to them as the "Big Five Hormones."

Insulin is a potent hormone. As a matter of fact, insulin is classified as an *anabolic hormone* because it increases the cellular uptake of blood sugar and protein[150]. Just as insulin is a powerful hormone, the Big Five Hormones are also heavy hitters with wide-ranging effects throughout the body. The Big Five Hormones are ***stress hormones*** because they activate the sympathetic nervous system and put us in a state of readiness[151].

The Counterregulatory Hormones That *Increase* Blood Sugar (The Big Five Hormones)

- Glucagon
- Adrenaline (secreted into the blood)
- Noradrenaline (adrenaline secreted into the tissues)
- Cortisol
- Growth hormone

Insulin's primary function is to reduce blood sugar, and it does so by decreasing gluconeogenesis. On the other hand, the five counterregulatory hormones raise blood sugar by synergistically working together to increase gluconeogenesis whenever blood sugar levels drop too low. When metabolism functions optimally, only a tiny quantity of the Big Five Hormones is needed to raise blood sugar. But when insulin and blood sugar levels oscillate between highs and lows throughout the day, greater and greater amounts of the Big Five Hormones are needed to raise blood sugar to healthy levels.

Metabolic Mayhem Increases Adrenaline and Noradrenaline Secretions

The counterregulatory hormones with the greatest capacity to raise blood sugar are adrenaline and noradrenaline[152,153]. As a result, these two potent stress hormones are secreted into the blood and tissues throughout the day to raise blood sugar, causing physical and psychological stress in the process. In fact, the constant secretions of adrenaline and noradrenaline that occur when metabolic mayhem sets in create more stress than anything else.

Note: metabolic mayhem increases Big Five Hormones levels. When these hormone levels are chronically elevated, your sympathetic nervous system, which produces the fight or flight response, is raring to go. As metabolic mayhem heals, Big Five Hormones levels drop, calming the sympathetic nervous system and activating the parasympathetic

nervous system. Most of us are so accustomed to being in fight or flight that when this occurs, we may confuse the experience of a peaceful baseline state with a lack of energy.

Insulin Resistance, Blood Sugar Swings and the Big Five Hormones Dysregulate Every Hormone in the Body

A carbohydrate-based diet causes blood sugar, insulin and the Big Five Hormones to yo-yo up and down throughout the day, which in turn causes other powerful hormones such as DHEA, testosterone, progesterone and estrogen to do the same thing. This bears repeating: every hormone in the body rises and falls in endless cycles so long as your blood sugar remains on a rollercoaster. This is why it's madness to attempt to balance any hormones—including thyroid hormones—so long as your insulin, blood sugar and the Big Five Hormones constantly cycle up and down.

When metabolism is healthy, blood sugar won't swing between high highs and low lows. Insulin will put the brakes on gluconeogenesis and bring blood sugar within healthy limits with ease. But when carbohydrates and sugar are consumed regularly, the endless cycling of insulin, blood sugar and the Big Five Hormones morph into a responsibility that insulin can't and wasn't designed to handle. Insulin can lower blood sugar when metabolism is healthy, but it was never meant to deal with chronically elevated blood sugar.

The constant cycling of every hormone in the body devastates our physical and psychological health. Hormone levels are meant to naturally rise and fall throughout the day and night. But as hormone levels are constantly driven out of balance by blood sugar swings, the body loses its ability to keep them within healthy limits, and hormone resistances develop.

Stress Hormones, Muscle Tension and Spinal Degeneration

The Big Five Hormones are stress hormones. Therefore, keeping their levels as low as possible is paramount. But as metabolic mayhem intensifies, stress hormone levels rise throughout the body. And as they do, the body's muscles can become chronically tight. Although any muscles can be affected by elevated stress hormone levels, the spinal muscles are common targets. This includes the head, jaw, neck, upper back, shoulders, lower back and pelvis.

As these muscles remain chronically tight, the healthy curves of the spine are lost, contributing to ***spinal degeneration***. Spinal degeneration occurs when the spinal bones (vertebrae) and discs degenerate. As spinal degeneration develops, pressure can be exerted on the spinal nerve roots and the spinal cord, leading to devastating consequences. Alarmingly, advanced states of spinal degeneration occur in more than 50% of adult populations, typically affecting the cervical and lumbar regions of the spine (the neck and lower back). Unfortunately, in my clinical experience, overcoming spinal degeneration is challenging as long as metabolic mayhem remains unhealed.

Carbohydrates, Depression and Antidepressants

Mood, personality and behavior are inseparable from hormone imbalances. A carbohydrate-rich diet causes endless insulin, blood sugar and Big Five Hormone swings, thus inducing an interminable number of hormone-mediated emotional highs and lows that can be extremely difficult (if not impossible) to remedy until metabolic mayhem is resolved.

How much of the world's reliance on antidepressants is caused by a carbohydrate-based diet? It's a rhetorical question, but just the same, it's impossible to regulate your moods and emotions so long as your blood sugar and stress hormones spike and plunge around the clock. As your blood sugar goes, so go your hormones. This may explain why there are 45 antidepressants on the market.

Addiction to Carbohydrates and Stress Hormones, Cyclothymia and Hormone Resistance

Sugar and carbohydrates are *highly* addictive (please refer to the Sugar Section for more information on the addictive nature of sugar). Part of the reason sugar and carbohydrates are so addictive is they drive our stress hormones up and down hundreds of times each day. *Cyclothymia*, a chronic mood disorder, is a mild form of bipolar disorder[154]. It's characterized by alternating states of mild mania (hypomania) and mild states of depression. Unlike bipolar

disorder, these states typically don't develop into full-blown mania or depression, but nonetheless are experienced as rapid, alternating highs and lows throughout the day.

Cyclothymic disorder is a chronic and impairing subtype of bipolar disorder that is largely neglected in research, particularly pediatric research. Consequently, cyclothymic disorder is rarely diagnosed, despite potentially being the most prevalent form of bipolar disorder[155,156,157]. In addition, a lack of understanding has added to confusion about the diagnosis and clinical presentation of cyclothymic disorder[158]. These factors cause this pervasive form of bipolar disorder to remain underdiagnosed.

Is there a link between the highs and lows of cyclothymia and the highs and lows of blood sugar, insulin and stress hormones? Many people try to ignore their emotional lows and chase after emotional highs. Sugar can do both—but it inevitably leads to highs that climb too high and lows that drop too low, sending stress hormones out of control. These rapid-cycling ups and downs wear us out, causing many to seek relief through antidepressants. Antidepressants may help with psychological issues, but psychological problems cannot be resolved unless any underlying blood sugar and hormone imbalances are cleared up.

Insulin Resistance + The Big Five Hormones Leads to Hormone Resistance

The carbohydrate-based diet forces the body to constantly create and break down stress hormones to maintain normal blood sugar levels. The creation and breakdown of hormones is known as *production* and *clearance*. One minute the body needs stress hormones to increase blood sugar; the next minute, the body desperately works to clear them to reduce blood sugar. This rapid cycling of stress hormones leads to ***hormone resistance***, in which the cells become desensitized to the effects of small shifts in hormone levels. When hormone resistance develops, greater and greater amounts of hormones are required to bring about the effects that were once generated by small adjustments in hormone levels.

As the body becomes resistant to hormones, e.g., cortisol, it's impossible to maintain healthy blood sugar, energy and cortisol levels. Cortisol dysregulation, which falls under the umbrella term ***adrenal fatigue/adrenal resistance***, is a prevalent health issue that plagues untold millions of Americans. However, the term *adrenal fatigue* is a misnomer; the real issue is *hormone resistance*. In many cases, the adrenal glands produce adequate or even excess hormones. The problem isn't necessarily a lack of hormones; it's that the rapid cycling (production and clearing) of these hormones causes their levels to vary wildly throughout the day. As hormone levels rise too high and fall too low throughout the day, the cells lose their ability to respond to small amounts of hormones. Just like insulin resistance, adrenal and all hormone resistance is a classic signaling issue that seriously affects health.

The Hormone Rollercoaster

The constant fluctuation between hormonal highs and lows is like a rollercoaster. A massive sugar and stress hormone rush is exciting and fun when a five-year-old gorges on cake and ice cream at a birthday party, but this sets the stage for self-induced stress, hormone resistance and future health issues. Some kids may get away with these highs and lows for a while, but when the pressures of adulthood come to call, these swings prove lethal as psychological and physical health issues seem to arise out of nowhere and often stick around like guests that have long since worn out their welcome.

As hormone resistance sets in, the emotional highs we once experienced from chowing down on carbs are replaced by an experience of gradually increasing emotional flatness. At this point, carbohydrates can become *highly* addictive, because we learn that eating increasingly large amounts of them will send our blood sugar into the stratosphere. Stratospheric blood sugar swings result in the payoff of a massive increase of stress hormones, including adrenaline and noradrenaline, providing us with the temporary high we're after (similar to getting angry throughout the day to beget a release of stress hormones). Unfortunately, this stress hormone-induced high leads to greater hormone resistance, opening the door to chronic depression and other psychological (and physical) health issues.

Chronically Elevated Insulin Drives Glucagon Levels Skyward—Which Causes Chronically High Blood Sugar

Glucagon, a principal Big Five Hormone, is secreted from the pancreas to increase blood sugar whenever it drops too low. Conversely, when blood sugar climbs too high, glucagon levels diminish. But as insulin resistance sets in and

insulin levels remain chronically high, the pancreatic cells that secrete glucagon become insulin resistant[159,160]. And when they do, glucagon—*which raises blood sugar*—continues to be secreted, even when blood sugar is already at excessive levels! This occurs even in the presence of sky-high insulin because the liver pays more attention to glucagon than insulin[161].

Glucagon Keeps Blood Sugar High Until Metabolic Mayhem is Healed

For glucagon secretions to normalize, insulin sensitivity must be re-established, and this can only happen as the many facets of metabolic mayhem are healed. This is yet another example of how hormone imbalances lead to hormone resistance, e.g., excess insulin secretions lead to insulin resistance. As various parts of the body become resistant to the effects of hormones, unanticipated and deleterious effects are generated. These effects have global consequences and can only be reversed as metabolic mayhem is healed.

Metabolism Recap #5: Metabolic Hormones

- Humanity's most pressing survival need for two million years was to raise blood sugar.
- The carbohydrate-centric Western diet now requires humans to lower blood sugar, which we're not designed to do.
- Humans have five hormones to raise blood sugar, but only one to lower it.
- Insulin is often incapable of controlling blood sugar when following a high-carbohydrate diet.
- This is because insulin was never intended to lower chronically high blood sugar.
- Humans *don't have (and never before needed) an effective tool for lowering blood sugar*.
- This is evidenced by the worldwide health crisis that's caused by the overfeeding of carbohydrates.
- Rather than managing dietary-induced blood sugar problems, insulin's job is to regulate gluconeogenesis.
- When metabolism is healthy, insulin can easily control gluconeogenesis.
- A high carbohydrate diet leads to blood sugar swings that are poorly controlled by insulin.
- Counterregulatory hormones, i.e., the Big Five Hormones, increase blood sugar. These include:
    - Glucagon
    - Adrenaline (secreted into the blood)
    - Noradrenaline (secreted into the tissues)
    - Cortisol
    - Growth hormone
- The Big Five Hormones are lifesavers when metabolism is healthy.
- Any dysregulation of the Big Five Hormones = health issues.
- As blood sugar alternates between highs and lows, stress hormones also swing between highs and lows.
- Blood sugar and stress hormone swings lead to significant physical and psychological stress.
- This dysregulates all hormones, e.g., estrogen, progesterone and testosterone.
- This leads to hormone resistance.
- Swings in blood sugar, insulin and the Big Five Hormones are highly addictive and lead to carb cravings.
- Glucagon is a powerful Big Five Hormone that increases gluconeogenesis.
- As insulin resistance progresses, the pancreatic cells that produce glucagon become insulin resistant, causing them to secrete too much glucagon around the clock—even after meals.
- Excess glucagon has the catastrophic effect of increasing already out-of-control gluconeogenesis.
- At this point, insulin loses control of gluconeogenesis and therefore blood sugar.
- In an insulin-resistant state, the liver pays more attention to glucagon than insulin.

What's Next?

Now that we've introduced the Big Five Hormones, we'll review *glycogen*, a form of blood sugar that plays a central role in switching to a fat-based metabolism.

Chapter 7:
Glycogen—The Gatekeeper of Ketosis

Once metabolic mayhem becomes sufficiently advanced, switching to a fat-based diet is physiologically impossible unless specific measures are taken to heal your metabolism. This is due to many reasons, including insulin resistance, out-of-control gluconeogenesis, glucagon dysregulation, and other factors that have yet to be introduced. One such factor that inhibits this switch is a storage form of blood sugar known as ***glycogen***.

First Things First: Glycogen Must Be Depleted to Burn Fats and Ketones

Humans store a small amount of blood sugar in the liver and skeletal muscles known as *glycogen* (*GLY*-co-jen). (A small amount of glycogen is also stored in the kidneys, brain, and red and white blood cells.) A crucial point about healing your metabolism and switching to a fat-based diet is that *glycogen* stores *must be largely depleted before the liver can cut back on its blood sugar production and begin pumping out enough ketones to power your body*[162]. If your metabolism is healthy, cutting carbs and sugar will deplete your glycogen stores and allow your liver to begin producing ketones within three days. But when metabolic mayhem spirals increasingly out of control, the liver pumps out so much blood sugar that your glycogen stores are continually replenished[163,164], stopping fat-burning in its tracks.

Glycogen consists of long chains of glucose that can be converted into blood sugar on an on-demand basis. The liver stores approximately 100 grams of glycogen, and the skeletal muscles store 400-900 grams[165,166]. (Trained athletes store twice as much muscle glycogen as untrained subjects[167,168].) Muscle glycogen can only be used in the muscle in which it resides. It can't be exported to other areas, which is why exercise is a vital component of depleting glycogen stores. The more ATP your muscles burn through, the more glycogen that's depleted. On the other hand, liver glycogen makes its way into the blood and can be consumed by any cell in the body. Therefore, liver glycogen can be used during times of exercise, or at any time that the body requires blood sugar.

Ketogenesis Can Only Happen When Glycogen Is Depleted

Without metabolic mayhem, eliminating carbohydrates and sugar for three days depletes glycogen stores and initiates the process of ***ketogenesis***. In ketogenesis, the liver cuts back on blood sugar production and simultaneously begins converting your fat stores into ketones. This process, which hinges on the depletion of glycogen stores, initiates the switch from blood sugar to fats and ketones. Depleting glycogen, then, is the gateway to ketogenesis. (Ketogenesis is synonymous with nutritional ketosis.) But as metabolic mayhem advances, out-of-control gluconeogenesis continually replenishes glycogen stores, making this switch impossible, *even if carbs and sugars are avoided for years*. That's the sobering reality of advanced metabolic mayhem.

The Confounding Nature of Glycogen Depletion

Once metabolic mayhem becomes advanced, the only way to switch to a fat-based diet is to continually deplete your glycogen stores more quickly than out-of-control gluconeogenesis replenishes them. Confoundingly, some patients dealing with advanced metabolic mayhem can cut out carbs and sugar and deplete their glycogen stores in three days. However, other patients who only exhibit modest signs of metabolic mayhem replenish their glycogen stores so rapidly that they must take continued action to deplete them, or they won't be able to switch to a fat-based diet, *no matter how long they cut carbs and sugar from their diet*. This is why it's common for people to try in vain for years to switch to a fat-based diet without ever successfully doing so.

To Deplete Glycogen, Cut Carbs, Sugar, Alcohol *and Fat* While Getting as Much Exercise as Possible

When glycogen stores are constantly replenished due to excess gluconeogenesis, it's necessary to do more than eliminate carbohydrates and sugar to initiate ketogenesis. When excess gluconeogenesis quickly replenishes glycogen stores, it's necessary to strictly limit carbohydrates, completely break up with sugar and alcohol, limit fat intake, consume moderate protein *and* exercise as much as possible. This is the formula for turning the tide on metabolic mayhem and switching to a fat-based metabolism. You must make these dietary changes, and you must get plenty of exercise. *You must do both*. This two-pronged approach doubles down on glycogen consumption, giving your liver the green light to cut back on its blood sugar production and begin converting your fat stores into ketones.

Why is it Necessary to Limit Fat Consumption When Metabolic Mayhem Becomes Advanced?

The never-ending replenishment of glycogen is *the principal hurdle* that gets in the way of healing metabolic mayhem and switching to a fat-based diet. When metabolic mayhem spins out of control, even the consumption of a few tablespoons of whipping cream, a salad or an egg—foods that don't increase blood sugar under normal circumstances—can send gluconeogenesis into warp drive and drive blood sugar up to 400 mg/dl, (or higher) in the presence of metabolic mayhem. In my experience, this nonlinear increase in gluconeogenic output subsides after three days of eliminating carbohydrates, sugar and consuming minimal protein and fat. This important point is reviewed in greater detail later in this section.

Exercise Burns Through Glycogen Stores and Lowers Insulin Levels

Exercise burns through your glycogen stores, and it also lowers insulin levels. Lowering insulin is crucial because high insulin levels block the release of *triglycerides* (tiny molecules of fat) from your fat cells. The liver creates ketones from triglycerides; high insulin means no triglycerides, and no triglycerides means no ketones. Thus, when insulin levels remain high, *blood sugar is the only fuel your cells can burn*. This is another reason to exercise as much as possible when switching to a fat-based diet, especially if you're insulin resistant, prediabetic or diabetic[169]. For some, the only way they can once-and-for-all transition into fat-burning mode is to exercise regularly, strictly limit carbohydrates, eliminate sugar and alcohol, restrict fat intake and consume protein in moderation. We'll return to this point throughout the rest of this section. Please refer to the Exercise Section for more information on Exercise.

Glycogen Replenishment: Why Metabolic Mayhem Is Like a Rubber Band

When I began helping patients switch to a fat-based diet, it was easy for most patients to create ATP from fats and ketones if they eliminated carbohydrates, sugar and alcohol, and if they also limited their consumption of fat and protein. In many cases, this transition would occur even without exercise. But when patients with advanced metabolic mayhem would increase their fat and protein intake on day four—even if they didn't reintroduce carbohydrates and sugar—metabolic mayhem would spin out of control. Their blood sugar would skyrocket, quickly replenishing their glycogen stores, and they would end up right where they began a few days prior.

As it became clear that three days wasn't enough to heal advanced metabolic mayhem, I had patients with damaged metabolism go on strict fasts. Patients would fast for two and even three weeks, make excellent improvements and drop weight they'd struggled to lose for years. But even after prolonged fasts, the moment these patients went off their fast and began eating foods—even if they didn't eat carbohydrates and sugar—metabolic mayhem would immediately redevelop, gluconeogenesis would spin out of control, blood sugar would skyrocket, and glycogen stores would quickly be replenished.

They were frustrated, I was flabbergasted, and I learned at the speed of failure that metabolic mayhem is like a rubber band. Through trial and error, I realized that to avoid the rubber band effect of out-of-control gluconeogenesis and never-ending glycogen replenishment, it's necessary to strictly limit the intake of carbohydrates, sugar and alcohol, and to limit the intake of fat and protein until metabolic mayhem is healed. This exceedingly important process is reviewed in detail later in this section.

Metabolism Recap #6: The Rubber Band Effect of Metabolic Mayhem

- The liver and skeletal muscles contain a storage form of blood sugar known as glycogen.
- The liver stores approximately 100 grams of glycogen, and the skeletal muscles store 400-900 grams.
- Glycogen stores must be largely depleted before the liver can cut back its blood sugar production and begin manufacturing ketones.
- Glycogen depletion is the tripwire that causes the liver to reduce the blood sugar production and begin making ketones. This age-old evolutionary survival strategy is known as *ketogenesis*.
- Humans have relied on ketogenesis for time immemorial. The superabundance of food in the modern world, especially in the form of carbohydrates and sugars, has made it much less necessary to boot up this once-common evolutionary strategy.
- If your metabolism is healthy, cutting carbohydrates and sugar will deplete your glycogen stores and initiate ketogenesis in 1-3 days. The more you exercise, the faster this happens.

- But when metabolic mayhem spirals increasingly out of control, the liver pumps out so much blood sugar that glycogen stores are replenished quickly.
- This is how metabolic mayhem can indefinitely interfere with ketogenesis unless specific steps are taken to heal metabolism.
- Muscle glycogen can only be used in the muscle in which it resides. It can't be exported to other parts of the body. The only way to deplete it is by exercising.
- Exercise is crucial in healing advanced metabolic mayhem, wherein excess gluconeogenesis constantly replenishes glycogen stores.
- Many people have been unable to enter a state of ketogenesis, even after abstaining from carbs and sugars for years.
- In addition to depleting glycogen stores, exercise also lowers insulin levels.
- When insulin levels are high, fat cells (adipocytes) can absorb but not release triglycerides.
- The liver produces ketones from triglycerides. Thus high insulin levels thwart ketogenesis and require your cells to create ATP from blood sugar.
- In the presence of advanced metabolic mayhem, consuming significant amounts of fat may trigger the liver to overproduce blood sugar for several hours. It's thus necessary to limit fat consumption to heal metabolic mayhem and initiate ketogenesis.

What's Next?

Now that you speak fluent glycogen, we'll focus on a very important subject that's crucial to your metabolic health: *fat*.

Chapter 8:
Freaked Out by Fat

This chapter introduces a weighty subject that freaks out almost everyone: *fat*. Fat has become the modern world's fall guy, but fat doesn't make you fat; carbohydrates and sugar make you fat. Fat is commonly referred to as ***triglycerides***. The two types of triglycerides you need to be familiar with are the fat circulating in your blood and the fat stored in your body, i.e., ***body fat***. Most humans have elevated triglyceride levels in their blood and excess fat stored in their bodies. This dangerous trend won't and can't stop until the world kicks its addiction to sugar and carbs. High triglycerides (too much fat in the blood) and excess body fat won't be cured by the low-fat craze, which exacerbates the world's fat problems.

De Novo Lipogenesis: The Effect of Out of Control Gluconeogenesis

When carbohydrates and sugar are consumed in excess, which is surprisingly easy to do, the carbohydrates and sugar that your cells can't absorb in the present moment will be converted to fat by the liver. This is ***de novo lipogenesis (DNL)***[170]. "De novo" means *to make new*, and "lipogenesis" is the creation of fat. De novo lipogenesis, then, is the creation of new fat. De novo lipogenesis occurs when we consume excess dietary carbohydrates and sugars, but it also occurs when the liver makes excess blood sugar via gluconeogenesis.

This is a very, very important point: as metabolic mayhem develops, the liver produces more blood sugar than the cells can use; excess blood sugar, *which is made in the body*, is then converted to fat. This leads to high triglycerides (too much fat in the blood) and excess body fat stores. As this dynamic becomes entrenched, it becomes increasingly difficult for the body to burn fat (both its own fat stores and dietary fat), because high blood sugar levels make it impossible for the cells to burn fat. Therefore, whenever I see high triglycerides on a lab test, I suspect the liver is making too much blood sugar *and* too much fat. I further suspect that excess gluconeogenesis is interfering with fat burning, and that metabolism must be healed before fat can be efficiently burned.

Why Statin Drugs and Blood Pressure Medications Are So Common

In today's sugar-crazed and carb-addicted world, having just the right amount of fat in your blood and body is exceedingly tricky. So it's no surprise that the most widely prescribed and most profitable drugs in the US and the world include medications designed to treat high cholesterol, high triglycerides, high blood pressure and the complications of diabetes—all of which are interrelated issues. These include statin drugs to treat high cholesterol and triglycerides, e.g., Zocor and Lipitor, blood pressure medications, e.g., Zestril, and drugs designed to treat the complications of diabetes-related issues, e.g., Metformin. The pharmaceutical industry makes billions of dollars yearly from these drugs, and can't continue to do so unless humans egregiously consume sugar and carbohydrates. Sadly, the amount spent on these medications pales compared to the nearly $200 billion spent on obesity-related illnesses, accounting for almost 21% of all medical spending[171].

Elevated Triglyceride Levels Contribute to Atherosclerosis

A hallmark of metabolic mayhem is elevated serum triglycerides, i.e., too much fat in the blood. Elevated triglycerides are a serious health issue and are strongly associated with cardiovascular disease. When triglyceride levels remain high, the immune system attacks them to reduce their levels[172]. This attack, which leads to atherosclerosis, i.e., plaque deposition within arteries, is inseparable from the progression of chronic inflammation. The following quote from the journal *Endocrinology* describes that the immune system attacks triglycerides:

> Innate immunity is the rapid self-defense response of our body to an environmental signature molecule [what the immune system recognizes as an invader] that is perceived as an injuring agent or something foreign, *in this case the hyperlipidemia* [excess triglycerides], rather than a bacterial lipopolysaccharide, viral double-stranded RNA (dsRNA), or CpG sequences in the DNA of infectious agents[173]. [Italics mine].

In other words, the immune system attacks excess triglycerides like a bacterial toxin or virus. This happens regardless of whether the excess fat in the blood comes from consuming too much sugar and carbohydrates, or if it comes from de novo lipogenesis. In either case, excess triglycerides initiate an immune response *in your blood*. Unfortunately, as

the immune system attacks excess triglycerides, it also damages the blood vessels, and *cardiovascular disease ensues*[174,175,176,177].

Atherosclerosis and Chronic Inflammation

The immune response against excess serum triglycerides causes atherosclerosis and *chronic inflammation*. It's been determined that various aspects of metabolic mayhem, e.g., insulin resistance and atherosclerosis, are inseparable from chronic inflammation. The implication of chronic inflammation in the development of metabolic disease is a major shift away from the traditional model in which the consumption of carbohydrates and sugar are thought to be the primary causes of insulin resistance, prediabetes and type 2 diabetes.

It's still true that the excess consumption of carbohydrates and sugar ultimately leads to metabolic mayhem. However, it's equally true that the excess consumption of carbohydrates and sugar give rise to chronic inflammation, which in turn co-creates and reinforces the various components of metabolic mayhem. Said differently, once chronic inflammation sets in, *it's impossible to heal insulin resistance unless chronic inflammation is concurrently healed*. Regardless of which causes which, the fact is that these conditions occur together and must be healed together. Chronic inflammation is explored in detail in the Chronic Inflammation Section. The connection between chronic inflammation and atherosclerosis is explored in much greater detail in the Cholesterol Section.

Body Fat and Metabolism

The overconsumption of carbohydrates and sugar leads to chronically elevated serum triglycerides, and excess serum triglycerides lead to excess body fat. Body fat is a surprisingly complex subject. Depending on how much and where body fat accumulates, it has completely different effects on your metabolism. Unsurprisingly, unhealthy fats accumulate in all the wrong places and negatively affect all aspects of your health. Fortunately, when your metabolism is healed and you follow the Metabolic Masterplan Diet, body fat stores become healthy and benefit all aspects of your health[178].

White Adipose Tissue (WAT) and Visceral Adipose Tissue (VAT)

Most of the body's fat stores are ***white adipose tissue (WAT)***. WAT, which can accumulate anywhere on the body, can be healthy or unhealthy, depending on how much and where it accumulates. The worst place to have too much WAT is *deep within the abdominal cavity*. The abdominal cavity is where your stomach, liver, pancreas, kidneys and intestines reside. ***Abdominal obesity*** develops when WAT accumulates between, around, and even within the organs in your abdomen; fat accumulation within the abdomen is a serious form of obesity. Moreover, abdominal obesity (the accumulation of WAT in the abdominal cavity) is associated with advancing disease states, including diabetes, high blood pressure and heart disease[179].

Abdominal Obesity

The accumulation of WAT in the abdominal cavity is known as abdominal obesity, and is technically referred to as ***visceral adipose tissue (VAT)***. The fact that the white adipose tissue (WAT) that stockpiles deep in the abdominal cavity is described in so many ways indicates how studied it is and how destructive it is to your health. VAT (visceral adipose tissue) is totally different from *belly fat*. Belly fat, which is also white adipose tissue, accumulates between the skin and abdominal muscles. Belly fat is the fat you can pinch and even take in your hands when too much gets deposited around your midsection. Unlike belly fat, VAT accumulates deep inside the visceral cavity. Just as you can't reach in and feel your internal organs, you can't reach in and feel the VAT inside your abdomen. When VAT stores increase, a person's abdomen appears swollen and distended, even in the absence of fat elsewhere on the body, even in the absence of belly fat.

Fat Secretes Powerful Hormones That Affect Metabolism

All fat is *metabolically active*, i.e., it secretes powerful hormones with unique biochemical characteristics. This is especially the case with visceral fat (VAT). When your fat cells secrete healthy amounts of hormones, your body can maintain *energy homeostasis*, i.e., just the right amount of body fat, the right hunger signal, and the right amount of ATP creation. But when excess visceral fat (VAT) accumulates, it secretes too many of some hormones and not enough of others, and the delicate homeostatic processes that govern metabolism spiral out of control.

Researchers didn't associate abdominal obesity with an increased disease risk until the 1980s, but abdominal obesity is now strongly associated with all-cause mortality (the increased risk of death from all causes)[180,181,182]. In particular, abdominal obesity is associated with chronic inflammation[183], insulin resistance[184,185], prediabetes[186,187], type 2 diabetes[188,189] cardiovascular disease[190,191,192,193], colorectal cancer[194], breast cancer[195] and prostate cancer[196,197,198,199,200,201]. Abdominal obesity is a major, major healthcare issue in the US and around the globe.

There are no precise parameters for the amount of VAT that must be present to diagnose abdominal obesity. Excess VAT, i.e., abdominal obesity, was initially assessed by measuring waist circumference. This is because the association between increased waist circumference and disease risk is correlative. Still, many people with modest increases in waist circumference and even normal waist sizes exhibit the symptoms of abdominal obesity, pointing to the need for an expanded definition of what constitutes abdominal obesity. More recent techniques for assessing the presence of visceral adipose tissue (VAT) include 3D body scans, CT scans and MRIs. These scans can detect the presence of VAT, but they cannot determine the types and amounts of hormones it secretes.

Confoundingly, some people with small VAT stores exhibit the signs and symptoms of advanced metabolic mayhem, while others with more significant VAT may demonstrate fewer adverse effects. In a disturbing trend, I find it's increasingly common for thin patients to develop advanced metabolic mayhem states. We'll return to this important topic later in the Metabolism Section.

Body Fat Distribution: Why Location Matters Most

The old saying "location is everything" applies to many things in this world, especially to body fat. When it comes to body fat, the *amount* of fat matters, the *type* of fat matters, but the *location* of body fat matters most. Humans store body fat in three different areas: within the abdominal cavity, the upper body and the lower body. Fat stored in the abdomen is abdominal fat, fat stored in the upper body is known as *android fat distribution*, and fat stored in the lower body is *gynoid fat distribution*.

Android, Gynoid and Subcutaneous Fat

Android and gynoid fat stores consist of ***subcutaneous adipose tissue*** (SAT)[202]. When too much SAT accumulates on the upper or lower body, it's known as ***android obesity*** and ***gynoid obesity***, respectively. Of the three types of fat distribution, research demonstrates that excess VAT, i.e., too much fat between the visceral organs—irrespective of your total body fat percentage—is more predictive of obesity and obesity-related complications than excess subcutaneous fat (SAT), regardless if it's on the upper body (android fat distribution) or lower body (gynoid fat distribution)[203]. It's thus no surprise that excess VAT is associated with a greater risk of cardiovascular disease than either android or gynoid obesity[204]. This isn't to say that excess SAT on your upper and lower body is healthy. It's not; it's just not as predictive of health issues as excess VAT.

Of the two types of SAT, i.e., android fat distribution and gynoid fat distribution, *android* fat distribution is associated with a greater risk of developing metabolic issues and cardiovascular disease than gynoid fat distribution[205,206]. SAT in the upper body is further classified as deep or superficial SAT. Deep SAT (DSAT) is carried deeper inside the skin, while superficial SAT (SSAT) is closer to the skin's surface. If you're more anatomically minded, DSAT exists below (deep to) the fascia superficialis, and SSAT exists between the fascia superficialis and the dermis.

A Review: Carbs, Insulin Resistance, Visceral Obesity, Dysregulated Hormones and Disease

High-carbohydrate diets significantly contribute to metabolic mayhem and cause chronic inflammation. In turn, metabolic mayhem and chronic inflammation cause insulin resistance, prediabetes, type 2 diabetes, and many other terminal diseases. A high-carbohydrate diet leads to obesity, including abdominal obesity. Excess VAT is a serious health issue resulting from and reinforcing metabolic mayhem. Excess VAT results from too many triglycerides floating around in the blood with nowhere to go. The immune system attacks these triglycerides, which damages blood vessels, contributing to cardiovascular disease.

Your fat cells, especially those within your visceral cavity, do their best to soak up excess triglycerides as quickly as possible. This leads to abdominal obesity, i.e., excess VAT. The accumulation of excess VAT sends metabolism further out of control by dysregulating the delicate hormone balance within the body. This explains the connection

between a high-carbohydrate diet, triglycerides, obesity, insulin resistance, prediabetes, type 2 diabetes, chronic inflammation and atherosclerosis. In addition, VAT increases all-cause mortality, and is strongly linked to psychological stress and chronic inflammation[207].

Let's Express the Previous Two Paragraphs in a Different Way:

- A high-carbohydrate diet causes chronic inflammation
- A high carbohydrate diet *and* chronic inflammation cause
    - Insulin resistance
    - Prediabetes
    - Type 2 diabetes
    - Obesity
    - Excess VAT—visceral adipose tissue
    - Excess WAT—white adipose tissue
- Excess WAT causes excess triglycerides
- The immune system attacks excess triglycerides, compounding chronic inflammation

Body Fat Is Assessed in These Ways:

- Amount—the percentage of body fat
- Type—visceral fat (VAT), android fat and gynoid fat
- Location—within the visceral cavity, the upper body and the lower body

Body Fat Accumulates in the Following Regions:

- VAT—within the abdominal cavity
- Android fat distribution—SAT that accumulates above the waist
- Gynoid fat distribution—SAT accumulates below the waist
- Upper body SAT is further classified as deep (DSAT) or superficial (SSAT)

What's Next?

Whew! We just learned a lot about fat, and there's much more to know to heal your metabolism and keep it optimized for decades to come. We'll now turn our attention to how fat controls your metabolism.

Chapter 9:
Fat Controls Your Metabolism

Ectopic Fat

It's important to have fat stored throughout your body. But as metabolism becomes unhealthy, fat is deposited in places where it was never intended to be stored, including inside the organs and skeletal muscles. This is known as ***ectopic fat***[208]. Ectopic means "in an abnormal place." Ectopic fat, which is WAT (white adipose tissue), is deposited in the liver, pancreas, kidneys, heart, coronary arteries, skeletal muscle and neck[209], with the liver being the most common site of ectopic fat accumulation. When ectopic fat stores develop, metabolic mayhem is becoming advanced, and it's an absolute given that your body's ability to use fat and ketones to create ATP is compromised.

Ectopic Fat in the Liver: Nonalcoholic Fatty Liver Disease

When ectopic fat stores in the liver replace approximately 4% of healthy liver tissue, nonalcoholic fatty liver disease (NAFLD) is diagnosed; when this percentage exceeds 8%, nonalcoholic steatohepatitis (NASH) is diagnosed[210]. NAFLD and NASH are increasingly common diseases, and are among the world's most pressing health issues[211]. In fact, nonalcoholic fatty liver disease (NAFLD) is currently the most prevalent liver disorder in developed countries[212,213,214]. NAFLD is common in overweight populations, and is becoming increasingly common in non-obese and non-diabetic populations[215,216]. Owing to its increasing prevalence and connection with the onset of many diseases, ectopic fat is widely studied in science and medicine, including in non-obese populations[217]. For example, consider the following quote from a 2013 article published in the journal *Nature Reviews Gastroenterology and Hepatology*[218]:

> NAFLD affects a large proportion of the US population and its incidence and prevalence are increasing to epidemic proportions around the world. As with other liver diseases that cause cirrhosis, NAFLD increases the risk of liver cancer, a disease with poor outcomes and limited therapeutic options.

Like visceral, android and gynoid fat stores, ectopic fat stores are serious health complications that must be eliminated to restore optimal metabolic function and minimize disease risk. Whereas carbohydrate-based diets contribute to NAFLD, the ketogenic diet improves NAFLD[219]. In all fairness, it would be remiss not to mention that less-nuanced ketogenic diets than the Metabolic Masterplan Diet are associated with worsening NAFLD in the scientific literature. There are two main reasons why this is likely to occur:

1. If a ketogenic diet is introduced before metabolic mayhem is healed, the body will be unable to efficiently metabolize fats, worsening NAFLD (and all aspects of metabolic mayhem). This is an excellent example of why it's necessary to heal your metabolism before switching to a high-fat diet.

2. Many ketogenic diets rely on excess protein intake, do not include a healthy balance of saturated and unsaturated fats, and include an overabundance of proinflammatory omega-6 fats. These factors lead to excess blood sugar and chronic inflammation, both of which contribute to metabolic mayhem and interfere with fat burning.

Ectopic Fat and Disease Risk

Ectopic fat accumulation is associated with numerous health issues and diseases, including metabolic syndrome, type 2 diabetes, cardiovascular disease and increased mortality[220,221,222,223,224]. *Metabolic syndrome* is associated with a fivefold increased risk of type 2 diabetes, a twofold higher risk of cardiovascular disease, a twofold to fourfold higher risk of stroke, a three to four times increased risk of heart attack and a two times higher death rate due to coronary events[225,226]. These factors contribute to the death of approximately 3.4 million humans worldwide each year[227,228].

The data on ectopic fat accumulations throughout the body are robust, but specific percentages and their associated risk for developing diseases, e.g., cardiovascular disease, are still being determined for organs such as the heart. Table 2 shows the percentage of ectopic fat accumulation in the liver, skeletal muscles and pancreas, and the risk they convey for developing diseases.

Table 2: Risk Status Associated With Ectopic Fat Accumulations by Organ

Organ	Low Risk	Moderate Risk	High Risk
Liver	3.66%	5.88%	8.26%
Skeletal Muscle	5.25%	7.56%	10.93%
Pancreas	5.98%	9.36%	11.69%

Source: [229]

Brown Adipose Tissue (BAT): The Good Fat

Most of the body's fat stores are made up of white adipose tissue (WAT). These include abdominal, android, gynoid and ectopic fat stores. When these fat stores become too large, they become your chief health hazard. But when white adipose tissue stores exist at optimal levels and only in the right places, they become one of your greatest strengths. The point isn't to eliminate all white adipose tissue, but to optimize its levels. Once optimized, white adipose tissue is crucial in keeping your metabolism healthy.

White adipose tissue gets most of the press these days, but another body fat important to know about is ***brown adipose tissue (BAT***). Brown adipose tissue was "rediscovered," so to speak, in 2007; until then, BAT was thought to exist only in infants[230]. Advances in radiological imaging techniques, most notably the PET scan, commonly used to detect cancer, began revealing metabolically active non-cancerous tissue that was subsequently identified as BAT. The rediscovery of brown adipose tissue has led to an explosion of BAT-related research, which has yielded significant insight into the many remarkable qualities of this exciting and healthy fat.

WAT Is Insulation, BAT Generates Heat

WAT controls metabolism by secreting adiponectin, leptin, triglycerides and cytokines. (We'll explore these critical metabolism-regulating hormones soon.) BAT also secretes metabolism-regulating hormones, but its outstanding feature is *adaptive thermogenesis,* i.e., the generation of body heat. BAT accomplishes this crucial feat by stimulating thyroid hormone production and increasing the amount of fat it burns in its mitochondria[231,232,233]. By burning lots and lots of fat, BAT excels at generating surprising amounts of warmth, not to mention burning excess body fat, which helps to keep your metabolism optimized.

When babies are born, they transition from a warm intrauterine habitat that remains at a constant 98.6 degrees Fahrenheit to a much cooler earthly environment. This abrupt transition requires babies to generate heat to maintain their core temperature once they're born into the world. Thermogenesis, then, is a crucial evolutionary strategy. It's thought that mammals have been storing BAT for about 150 million years, meaning that BAT and adaptive thermogenesis are ancient survival mechanisms that have developed lockstep with mammalian life through eons of time[234].

It's unclear if all humans have BAT, or precisely how much of it they possess[235,236,237]. What is known is that the more white adipose tissue (WAT) you're carrying around, *the less active your BAT becomes* and the less body heat it generates. A simple analogy is that WAT acts as insulation to keep your body warm, whereas BAT is like a wood stove that produces and radiates a surprising amount of heat. However, BAT's "wood stove" can only be fired up when WAT levels are at or near optimal levels. As WAT levels become optimized, BAT becomes more metabolically active and expands. This expansion produces more heat and stabilizes metabolism[238]. To reiterate, optimizing BAT is only possible when WAT stores are optimized.

BAT, Brite, Beige, Browning and Inducible Adipose Tissue

Recent investigations into brown adipose tissue have also revealed the existence of beige, "brite" and inducible adipose tissue. These terms are used interchangeably in the scientific literature, and describe the phenomenon in which brown adipose tissue develops within existing white adipose tissue stores. This is also called the "browning" of white adipose tissue, or "brown-in-white" adipose tissue. All of these terms refer to the healthy expansion of brown fat, which occurs naturally as WAT stores normalize. This expansion of brown fat happens in response to cold exposure and when you switch to a ketogenic diet[239,240,241]. To minimize confusion, I'll refer to brite, beige and inducible fat as *brown-in-white* adipose tissue throughout the rest of the Metabolism Section.

In addition to generating the heat that mammals require for their survival, BAT and brown-in-white adipose tissue are strongly correlated with leanness[242,243,244], protect against obesity[245], and serve as a safeguard against excess serum triglycerides (fat in the blood) when following a high-fat diet[246,247,248,249,250,251]. BAT and brown-in-white fat tissues *must consume fat*, and therefore thrive on a high-fat diet once WAT stores are optimized and metabolism is healed[252]. Just as all the components of metabolism become dysregulated at the same time, so do they heal at the same time. As your metabolism heals and you convert to the Metabolic Masterplan Diet, WAT stores decrease (or increase), and BAT and brown-in-white stores naturally expand[253].

WAT and BAT Are Very Different Types of Fat

BAT and brown-in-white adipose tissue are surprisingly different from white adipose tissue (WAT)[254]. WAT cells contain one massive central fat droplet, while BAT and brown-in-white cells contain numerous tiny droplets of fat[255]. Unlike WAT, BAT and brown-in-white adipose tissue have a rich blood and nerve supply, contain vast mitochondria, and convert large amounts of nutrients, predominantly fat, into body heat. Both BAT and WAT are recognized as *endocrine organs* that secrete metabolism-regulating hormones[256]. WAT secretes adiponectin, leptin, triglycerides and cytokines, while BAT and brown-in-white adipose tissues secrete unique chemicals, including ***uncoupling protein-1 (UCP1)***[257].

BAT Transfers Heat to Blood Vessels

UCP1 is also known as *thermogenin*, a name that describes its role in adaptive thermogenesis. Most BAT exists adjacent to major blood vessels within the thoracic cavity (the area inside the ribcage). Such placement allows the heat generated by BAT to be transferred to major blood vessels and carried to the rest of the body via the circulatory system[258,259,260]. As BAT and brown-in-white adipose tissues express more UCP1, BAT consumes large amounts of fat; this lowers fat stores, maintains healthy blood sugar and triglyceride levels, contributes to ***metabolic homeostasis***, and keeps you warm[261].

The creation of brown-in-white adipose tissue is a rare example of *transdifferentiation*, which is the transformation of one cell type (WAT) into another (BAT) *without reverting back*[262]. As WAT and BAT stores optimize, they function together to prevent insulin resistance. Healthy WAT and BAT increase adiponectin secretions (we'll get to adiponectin soon), which protects against insulin resistance[263], and BAT's thermogenesis also prevents against insulin resistance[264]. The ketogenic diet produces a 1.5 to 3-fold increase in BAT metabolism, increasing the size of mitochondria within BAT by 60%[265].

The Metabolic Masterplan Diet has been carefully designed to help you shed unhealthy fat and keep it gone forever, and it optimizes healthy WAT, BAT and brown-in-white fat stores. However, the Metabolic Masterplan Diet isn't per se a weight loss tool. Its purpose is far beyond helping you lose fat. Instead, the Metabolic Masterplan Diet optimizes your fat stores, which happens as you heal your metabolism. When your metabolism is healed, and you feed your body what it requires to remain healthy, you don't need a weight-loss tool.

Fat Is an Endocrine Organ That Controls Your Metabolism

It was once thought that fat is nothing more than a means of storing energy for times of starvation, but it's now known that fat is a powerful *endocrine organ.* Endocrine organs like the thyroid gland secrete hormones that exert a mighty influence over the function of every cell in the body. Science has found that the fat cell, i.e., the ***adipocyte***, is the basic functional unit that controls your metabolism[266]. Wait. Fat cells *control* my metabolism? Yes, fat cells are in charge of your metabolism. It's a far-out fact about fat cells: they indisputably control your metabolism. Metabolism isn't governed by your brain, bad karma or rogue genetics; when it comes to metabolism, fat is what it's all about.

Adipokines: The Molecules That Regulate Metabolism

Your fat cells (adipocytes) form a powerful endocrine organ that controls your metabolism by secreting hormones called ***adipokines***. Two key adipokines are ***adiponectin*** and ***leptin***. Adiponectin, leptin, and triglycerides form the nexus that controls your metabolism[267]. As too much abdominal, android, gynoid and ectopic fat accumulates, adiponectin, leptin and triglyceride levels become dysregulated. Once this happens, metabolic mayhem becomes entrenched *and cannot be healed until excess fat stores are shed*. Excess fat stores are synonymous with adiponectin and leptin resistance, conditions in which the cells become less responsive to the effects of these homeostatic hormones[268,269].

In addition to adiponectin and leptin, adipocytes also release potent proinflammatory signaling molecules known as ***cytokines***. When too much fat is stored in the body, adipocytes secrete too many cytokines, resulting in chronic inflammation. Being overweight, then, *is* chronic inflammation. So long as adiponectin, leptin, triglycerides and proinflammatory cytokine levels remain imbalanced, it's impossible to balance blood sugar, insulin and stress hormone levels. Healing the various components of metabolic mayhem is only possible when fat stores are optimized.

Adiponectin Controls Insulin Sensitivity and Gluconeogenesis

Adiponectin controls *insulin sensitivity,* i.e., how sensitive the cells are to insulin. Contrary to popular opinion, insulin's primary means of regulating blood sugar is by controlling the amount the liver produces, *not by increasing the rate at which the tissues absorb blood sugar*[270,271]. When metabolism is healthy, only a tiny amount of insulin is required to fine-tune the amount of blood sugar the liver produces. But when fat stores become too large and adiponectin levels drop, the liver becomes insulin resistant and produces more blood sugar than the body can burn. This excess blood sugar is converted into fat by being absorbed by adipocytes or converted to fat via de novo lipogenesis. This desperate state of affairs is what's known as a *vicious circle.* A vicious circle is a complex chain of events that negatively reinforce themselves. A vicious circle cannot change until something breaks the cycle.

Fat Stores Must Shrink Before Gluconeogenesis Is Optimized

Insulin sensitivity must be restored to control gluconeogenesis, but this can only happen when fat stores are diminished. The extent to which fat stores must be depleted to allow the liver to become more sensitive to the effects of insulin varies from person to person. In my experience, once metabolic mayhem becomes extreme (and the longer it remains extreme), the greater the likelihood that fat stores will need to be *almost entirely depleted* before adiponectin levels can increase and insulin sensitivity can be restored. But, again, this varies from person to person. The only way to determine how much fat must be depleted to regain insulin sensitivity is to take the steps necessary to heal your metabolism and see what happens. This decisive point is explored in detail in the coming chapters.

The Adipocyte Is the Powerbroker of Metabolism

When your fat stores are optimized, your adipocytes (fat cells) become the metabolic powerbrokers that control your metabolism and many other essential health functions. These include the expression of genes, hormones and enzymes. The primary reason adipocytes are the powerbrokers of metabolism is that *they control the balance of adiponectin*. Many chemicals play a crucial role in regulating metabolism, but adiponectin is the star of the show.

Adiponectin possesses "pleiotropic protective effects[272]." One of adiponectin's many effects is *gene regulation*. A pleiotropic protective effect means a single gene can generate two or more unrelated effects. Obesity severely hampers genetic expression, thereby interfering with adiponectin's pleiotropic effects. Medicine continues to seek out genetic causes for the world's out-of-control diseases, but solutions won't be forthcoming until the obesity epidemic is overcome and adiponectin can work its metabolic magic. As we'll see in The Art of Healing and Optimizing Your Gut Section, H. Pylori, an opportunistic bacteria that commonly inhabits the stomach and duodenum, suppresses adiponectin levels[273].

Leptin and Metabolic Mayhem

As metabolic mayhem worsens and fat stores expand, leptin secretions increase. Excess leptin secretions lead to leptin resistance, which causes the brain to pay less attention to this metabolism-regulating hormone. Leptin controls the hunger signal, and as fat stores and leptin levels increase, it becomes increasingly difficult to control your food intake.

Obesity: The Pandemic Underlying All Pandemics

The modern world's addiction to carbohydrates and sugar has led to an epidemic of untold proportions: obesity. The following obesity statistics speak for themselves, and they speak quite loudly:

- 35% (77 million) Americans are obese (CDC, NIH)[274]
- Childhood obesity rates have tripled since 1980 (CDC, NIH)[275,276]
- Obesity leads to heart disease, stroke, diabetes, cancer and other conditions (CDC, NIH)[277]
- Obesity is the leading cause of preventable death (CDC, NIH)[278]
- 37.9% of adults aged 20 and over are obese (2013-2014 CDC, NIH)[279]

- 70.7% of adults aged 20 and over are overweight or obese (JAMA, CDC)[280]
- 20.5% of adolescents age 12-19 are obese (CDC)[281,282,283]
- 17.7% of children aged 6-11 are obese (2011-2012 CDC, NIH)[284]
- 8.4% of children aged 2-5 years are obese (2011-2012 CDC)[285,286]
- The average American was 24 pounds heavier in 2013 than in 1960 (CDC)[287]
- Worldwide obesity has more than doubled since 1980 (WHO)[288,289]
- In 2014, more than 1.9 billion adults were overweight (WHO)[290]

Here's What the Alphabet Soup Means:

- CDC: Centers for Disease Control
- NIH: National Institutes of Health
- JAMA: Journal of the American Medical Association
- WHO: World Health Organization

These are brutal statistics, and they're projected to worsen with time. Billions of people worldwide are overweight, and the world is getting fatter each year. Being overweight or obese predisposes us to every disease and condition there is. What diseases are associated with obesity? Cancer, heart disease, diabetes, stroke, atherosclerosis, Alzheimer's, kidney disease, and the list goes on. Weight issues don't lead to health issues, weight issues *are* health issues.

The Unfamiliarity With Healthy Fat Stores and Ideal Weight

In a world where weight issues are the norm and relatively few adults can effortlessly maintain healthy fat stores without constant dieting or extreme exercise, we're losing context for what being healthy looks and feels like. But when metabolic mayhem is healed and your body can efficiently burn fats and ketones, your fat stores naturally become optimized. Sadly, however, optimized fat stores are such a rarity in the modern world that it may take a while for you and those who know you to get used to how healthy you look.

Humans have been steadily becoming heavier since approximately 1960. We're so much heavier than we were only a few generations ago that *we've lost touch with what healthy humans look like:* overweight and obesity issues have become so common that we mistakenly accept them as normal. If you hear comments such as, "You're too thin" once your metabolism heals, keep in mind that being at your optimal weight may seem "too thin" to a world that's heavier than ever before—especially to those who may still be carrying excess weight.

The fact is that the modern world needs clarification about what constitutes ideal weight. If you can effortlessly maintain healthy muscle and fat stores without dieting, and if your blood sugar, triglycerides and cholesterol values remain optimized and you feel better than ever, you're at your ideal weight, regardless of anyone's opinions to the contrary. Healthy fat stores are characterized by modest amounts of android and gynoid fat, and robust BAT and brown-in-white fat stores. Just as there exists a natural variability in muscle mass from person to person, there also exists a natural variability in the amount of healthy fat humans carry. What's healthy for one person may be too much for another and not enough for someone else. When your metabolism is optimized, your body will naturally find the right level for you. Trust your body. It knows. Don't trust the opinions of others. They often mislead, even when well-intended.

Summarizing Fat

As VAT, SAT, WAT, BAT and brown-in-white fat stores become optimized, your metabolism breaks free of the leash it's been struggling against. When VAT, SAT and WAT levels trend far enough in the right direction, ectopic fat melts away, and BAT and brown-in-white stores can expand[291]. Normalizing VAT is the first domino to fall in the healing of metabolism. Once fat stores are optimized, the four main controllers of metabolism—adiponectin, leptin, triglycerides and proinflammatory cytokines—can also be optimized.

Adiponectin and leptin are adipokines. Adipokines are metabolism-regulating hormones that are secreted from adipocytes (fat cells). As visceral, android, gynoid and ectopic fat stores become too large, adiponectin levels plummet, and leptin levels rise. Decreasing adiponectin levels increase the insulin sensitivity of fat cells, causing visceral adipose tissue (VAT) to soak up more triglycerides than other fat cells, compounding visceral obesity. Excess VAT is predictive of obesity-related health issues and cardiovascular disease[292,293,294,295,296,297,298,299,300,301,302,303].

Thus optimizing VAT stores is the first step in healing your metabolism. As VAT levels are brought within a healthy range, the adipocyte can once again exert its role as the controller of metabolism, which it does by optimizing adiponectin, leptin, triglyceride and cytokine levels[304]. These primary controllers of metabolism can then optimize insulin sensitivity and stave off the development of insulin resistance, metabolic syndrome and type 2 diabetes. Optimized adipocyte secretions also control glucose metabolism, cholesterol values and prevent cardiovascular disease[305,306,307].

Healthy fat cells regulate how much fat your body stores and how much it burns, which is *metabolic homeostasis*[308]. Metabolic homeostasis can only occur when VAT, SAT, WAT, ectopic, BAT and brown-in-white fat are healthy. Healthy fat stores absorb excess dietary triglycerides[309,310,311,312,313,314], protecting against the metabolic damage incurred from overfeeding, de novo lipogenesis and obesity[315]. This provides both protection and long-term energy storage[316]. The ketogenic diet produces a 1.5 to 3-fold increase in BAT metabolism, increasing the size of mitochondria within BAT by 60%[317].

Being Lean and Getting Plenty of Exercise Doesn't Rule Out Metabolic Mayhem

In the modern world, being lean is no guarantee that you're healthy, nor is getting plenty of exercise. For example, it's estimated that 50% of college football linemen have metabolic syndrome (a common condition characterized by several indicators of metabolic mayhem)[318]. In addition, an increasing percentage of the lean population is known as *metabolically obese:* even though they're thin, they're insulin resistant and have significant accumulations of ectopic fat in their liver and skeletal muscle cells. Fatty deposits in these areas were once observed only in obese subjects, but are now common in non-obese and even lean populations. The increasing prevalence of metabolically obese subjects is called the *lean insulin-resistant phenotype*[319].

Many keto resources make switching to a fat-based diet seem easy, but most patients I work with must heal metabolic mayhem before they can create ATP from fat and ketones. I rely on metabolic biomarkers and blood sugar readings to determine if a patient has developed metabolic mayhem. I won't guess with a patient's health, and I recommend that you don't guess with yours. Successfully implementing the Metabolic Masterplan Diet hinges on measuring metabolic biomarkers and monitoring your blood sugar. If you don't know what's going on with your biomarkers and blood sugar, you have no way of knowing what's going on with your health. Don't play guessing games with your health. Measure your biomarkers and make informed, empowered healthcare decisions.

Recapping Metabolic Mayhem

Rather than attempting to keep all the information we've covered thus far in the Metabolism Section fresh in your mind, *read on*. Everything we've covered that needs consideration has been carefully outlined in the coming chapters. But before we focus on what's involved in healing metabolic mayhem, let's summarize its main components.

The Components of Metabolic Mayhem That Must Be Addressed to Heal Your Metabolism:

1. Insulin resistance must be eliminated, and insulin sensitivity must be restored
2. Counterregulatory hormone levels (glucagon, adrenaline, noradrenaline, cortisol and growth hormone) must remain at optimal levels
3. Gluconeogenesis (the liver's production of blood sugar) must remain at optimal levels at all times
4. Visceral, android and gynoid fat stores must be brought within healthy limits
5. Ectopic fat stores must be eliminated
6. Adiponectin, leptin, triglyceride and proinflammatory cytokine levels must be optimized (adiponectin levels typically need to increase, and leptin levels need to decrease)
7. Chronic inflammation must be banished
8. Blood sugar must remain within healthy limits at all times
9. De novo lipogenesis must remain low at all times
10. The ability to metabolize fats and ketones must be restored

Cortisol

One of the five counterregulatory hormones, *cortisol* is a crucially important compound produced by the adrenal glands. Unlike anabolic steroids, which are derivatives of testosterone that increase muscle mass, cortisol is a *glucocorticoid hormone*. Glucocorticoid hormones are a class of steroid hormones that exert powerful effects on metabolism, behavior and immune function[320]. In addition, due to its strong anti-inflammatory properties, cortisol plays a crucial role in regulating the inflammatory response.

But when cortisol levels climb too high or drop too low, its healing properties vanish, and this potent glucocorticoid can thwart the healing process and hasten disease. Dysregulated cortisol levels are a deadly serious matter, but they can only be brought into healthy balance when the underlying causes of dysregulation are addressed. The same factors that dysregulate blood sugar and insulin—the Western diet, stress and declining states of health—these factors similarly dysregulate cortisol levels. Thus when cortisol levels climb too high or drop too low, the only way to bring them back within healthy limits is to heal your metabolism and optimize as many components of the Short List as possible. There are no shortcuts in healthcare, and cortisol is no exception.

Cortisol Production, Regeneration and Clearance

The cortisol in your tissues, cells and blood is determined by the amount of cortisol produced by the adrenal glands, the amount that's inactivated, and the amount that's reactivated (usually referred to as regeneration). Thus cortisol levels are the interplay of production, regeneration and clearance.

The adrenal glands produce cortisol. If serum cortisol levels climb too high, the enzyme *11β-hydroxysteroid dehydrogenase (11β-HSD)* deactivates cortisol into cortisone. Cortisol is the active form of this vital hormone, and cortisone is its inactive form. If serum cortisol levels drop too low, the enzyme *11β-hydroxysteroid dehydrogenase-1 (11β-HSD1)* converts cortisone (inactive) to cortisol (active). Cortisol and cortisone continuously circulate throughout the body; 11β-HSD1 and 11β-HSD are the enzymes that maintain healthy cortisol levels by activating and deactivating them.

Cortisol Production, Regeneration and Clearance:

- Cortisol is produced by the adrenal glands
- 11β-HSD1 converts cortisone (inactive) to cortisol (active)
- 11β-HSD deactivates cortisol into cortisone

The Effects of Metabolic Mayhem on Cortisol Levels

Metabolic mayhem damages the body in many ways, including the dysregulation of cortisol levels. As metabolic mayhem intensifies, cortisol levels increase. This leads to increased blood sugar, weight gain, insulin resistance, elevated blood pressure, impaired affect and other health issues.

The Effects of Healed Metabolism on Cortisol Levels

High or low cortisol levels are caused by metabolic mayhem, stress and many other factors. Your cortisol levels will naturally become optimized as your metabolism heals and your overall health becomes optimized. Conversely, dysregulated cortisol levels occur concomitantly with various health issues, including those associated with metabolic mayhem. The bottom line is that it's only possible to optimize cortisol levels when all aspects of your life and health are optimized. In this, there can be no exceptions.

Summarizing the Metabolism Section

The ultimate purpose of metabolism is to produce an abundance of metabolic energy (ATP) in your cells. Your cells require an incredible amount of energy to perform their many functions. The instant your mitochondria aren't able to produce the energy they require is the instant your overall health begins to decline. This is why an inefficient metabolism decreases longevity, lifespan, healthspan, healthy aging and quality of life, and increases the risk of chronic diseases and all-cause mortality—and it's why an optimized metabolism produces the exact opposite effects.

The high-carbohydrate Western diet damages metabolism, thus limiting the production of ATP in every cell of your body. Producing ATP from fats and ketones heals the metabolic damage caused by the Western diet and leads to mitohormesis. In mitohormesis, your mitochondria produce more ATP, fewer reactive oxygen and nitrogen species

(RONS), and they make more antioxidants. Mitohormesis also cues the body to produce more mitochondria. Only the ketogenic diet induces the powerful, life-enhancing benefits of mitohormesis.

Nutritional ketosis begins by strictly limiting your intake of carbohydrates, sugar and alcohol. A state of nutritional ketosis depletes glycogen stores, reduces basal and bolus insulin secretions, restores glucagon sensitivity, reduces gluconeogenic output, allows triglycerides to exit fat cells and enter circulation, and cues the liver to produce ketones from fat, i.e., ketogenesis. This crucial metabolic shift allows the cells of the body and brain to utilize both ketones and fat to create ATP, typically within three days of limiting the intake of carbohydrate, sugar and alcohol.

Of great concern is that entering into a state of nutritional ketosis is relatively easy, but remaining in this state when protein and fat are consumed, even in small amounts, can be tricky for many people once metabolic mayhem develops. Some people who've developed advanced metabolic mayhem can heal it simply by restricting their intake of carbohydrates, sugar and alcohol, but others can't. Those who aren't able to heal it *must* remain at Step 2 of the MMD *until their metabolism heals*. This commonly entails remaining at Step 2 until excess fat stores have been shed, which restores adiponectin signaling.

If you experience difficulty healing metabolic mayhem, it's likely due to excess gluconeogenesis, which quickly replenishes glycogen stores. When glycogen stores are depleted through restricting carbohydrate and sugar intake *and* getting plenty of exercise, your body undergoes the physiological shift into nutritional ketosis. Unfortunately, many people find it necessary to continually deplete glycogen stores in the early stages of healing metabolic mayhem to remain in nutritional ketosis. If you find this to be the case, be mindful of your fat and protein intake, and exercise daily.

Metabolic Mayhem Includes These Components:

- Excess gluconeogenesis (blood sugar produced by the liver)
- Insulin resistance (when your cells become less responsive to insulin)
- Prediabetes or type 2 diabetes
- Imbalanced counterregulatory hormones (glucagon, adrenaline, noradrenaline, cortisol and growth hormone)
- Excess VAT (visceral adipose tissue)
- Obesity or overweight
- Chronic inflammation
- Cholesterol dysregulation
- Elevated triglycerides
- The diminished capacity or inability to metabolize fats and ketones
- Blood sugar dysregulation
- Elevated A1c test
- Constantly replenished glycogen stores
- Increased production of RONS (reactive oxygen and nitrogen species)
- Decreased production of ATP
- Atherosclerosis
- Sarcobesity
- Ectopic fat accumulation
- Excess de novo lipogenesis
- Adiponectin dysregulation
- Leptin dysregulation

What's Next?

When it's all said and done, these are the main components of metabolic mayhem that must be addressed to heal your metabolism and switch to a fat-based diet. Taking a "throw it against the wall and see what sticks" approach to switching to a fat-based diet is frustrating at best and downright dangerous at worst. Rather than taking chances with your health, follow the Metabolic Masterplan Diet. The Metabolic Masterplan Diet is more than a diet. It's a step-by-step plan of action that guides you through the process of healing metabolic mayhem and *successfully* switching to a fat-based diet. Now that metabolic mayhem has been thoroughly introduced, we'll focus on *metabolic biomarkers*, which are measured to ensure that you truly are healing and optimizing your metabolism.

Chapter 10:
Metabolic Biomarkers

How can you absolutely positively know if you've developed metabolic mayhem? By measuring ***metabolic biomarkers***. How do you determine if you've developed a little or a lot of metabolic mayhem? Measure metabolic biomarkers. How can you be 100% certain that your steps to heal metabolic mayhem are working? Measure metabolic biomarkers. How do you know your metabolism is healthy enough to successfully switch to a fat-based diet? Measure metabolic biomarkers. How do you know that your metabolism has become optimized? By measuring metabolic biomarkers. How can you prove that your risk for developing common diseases such as diabetes and cardiovascular disease has been dramatically reduced? It's all in your metabolic biomarkers.

Don't Guess With Your Health: Measure Metabolic Biomarkers

Metabolic biomarkers don't lie. They're metabolic polygraph tests that tell you the truth about your metabolism. If you want to know if you've broken a bone, take x-rays. If you want to experience genuine happiness, forgive. And if you want to know what's going on with your metabolism, measure metabolic biomarkers. Don't mess around with metabolic mayhem. Don't guess. *Know*. Don't hope that everything is okay. Figure it out for sure by measuring metabolic biomarkers. If you'd like to greatly increase the odds of becoming a healthy centenarian, pay attention to your biomarkers.

Most metabolic biomarkers are molecules in your blood, e.g., triglycerides, and are measured via lab tests to indicate what's going on with your metabolism. Other metabolic biomarkers are assessed with body scans or by observing changes in your body. By testing and tracking metabolic biomarkers, a wealth of information is gained about all aspects of your metabolism. Some metabolic biomarkers, e.g., insulin and adiponectin, were introduced earlier in the Metabolism Section, while others have yet to be reviewed.

Measuring Metabolic Biomarkers Is Easy and Inexpensive

Each biomarker is a topic unto itself. We'll review biomarkers in enough detail for you to know what they are, why it's essential to measure them, how to measure them, and how to interpret them correctly. Metabolic biomarkers provide penetrating insights into every aspect of your metabolism that can't be gained through any other means. Except for body fat, ectopic fat stores and resting heart rate (see the Exercise Section), biomarkers are measured via blood tests.

Testing for biomarkers is fast, easy and surprisingly inexpensive. By running just two tests—the hemoglobin A1c test and the nuclear magnetic resonance test (referred to as the NMR)—you can assess 13 critically important metabolic biomarkers for about $150.00. The metabolic biomarkers assessed with an NMR test have been designated with an asterisk in Table 3. Having these important tests run *before making changes to your diet* is crucial. In addition, more and more states allow patients to order blood tests online without going through a healthcare provider. This reduces your healthcare costs and puts the power to make your own healthcare decisions where it belongs: in your own hands.

Table 3: Metabolic Biomarkers

Hemoglobin A1c	Blood sugar	Triglycerides*
The triglyceride/HDL ratio*	HDL cholesterol*	HDL-P (the number of HDL particles)*
HDL particle size*	LDL cholesterol*	LDL-P (the number of LDL particles)*
LDL particle size*	VLDL cholesterol*	VLDL-P (the number of VLDL particles)*
VLDL particle size*	The cholesterol ratio*	Ox-LDL
The apoB/apoA-I ratio	Lp(a)	Insulin
Adiponectin	Leptin	The omega 3:6 ratio
Body fat (visceral, android and gynoid)	Ectopic fat stores	Ketones**

* Denotes metabolic biomarkers that can be measured or calculated with an NMR test.

**Ketones aren't a reliable metabolic biomarker. This is due to normal fluctuations of both blood and urinary ketone levels. This is explored later in this section.

Reference Ranges

When blood tests are performed to measure metabolic biomarkers such as triglycerides, your results are compared against ***reference ranges*** to determine if your blood chemistries are within normal limits. In many cases, government and medical reference ranges are so broad that many developing (and already developed) health issues go undetected when lab tests are performed. Furthermore, reference ranges have been created over several decades and are based on *glucose-adapted populations of average health at best*. Reference ranges in no way represent optimal lab values, nor are they intended to. When your metabolism is healed and you're burning fats and ketones, some of your lab values will fall outside of putative "healthy" reference ranges.

This is critically important: reference ranges have become so broad that many unhealthy lab findings fall within "healthy" reference ranges, and some optimized lab values fall outside "healthy" reference ranges. This is a real problem if your healthcare provider (or well-intentioned friend, coworker, spouse, or internet search) misinterprets your optimal lab values because they don't fit within conventional reference ranges. Unfortunately, when this occurs, many healthcare providers reflexively dispense party-line advice (and party-line medications) to force you back within so-called "healthy" reference ranges.

This is so important that it's reiterated again: once your metabolism is healed and fat becomes your primary fuel source, the normal range for some metabolic biomarkers can no longer be relied on. This is true for blood sugar, hemoglobin A1c, triglycerides and *all cholesterol values*. Cholesterol reference ranges are notoriously problematic, dogmatic, and so heavily influenced by the pharmaceutical industry that relying on them is ill-advised—especially when your metabolism heals and you're burning fat and ketones. Optimal lab values for metabolic biomarkers are shown in Table 9.

Metabolic Biomarkers Defined

Hemoglobin A1c

The hemoglobin A1c test computes your *average* blood sugar for the previous 120 days. Blood sugar is sticky, and it sticks to your red blood cells. Thus by measuring the amount of blood sugar attached to your red blood cells, it's possible to estimate the amount of blood sugar circulating throughout your body during the last four months. This is because the typical lifespan of a red blood cell is 120 days.

Comparing your A1c results before and after switching to the Metabolic Masterplan Diet makes it easy to determine if your blood sugar is trending in the right direction. Most lab facilities that test blood chemistries can perform an A1c test for you, or you can pick up a do-it-yourself A1c kit at your local pharmacy and test it yourself.

As your metabolism heals and you become deeply fat-adapted, which can take a year or more, your A1c readings will likely be at or below 5.0. *An A1c ≤5.0 is impossible in most cases when you're glucose-adapted*. However, when your metabolism is healed *and* you're diligent with your diet *and* you get plenty of exercise *and* stress is kept to a minimum (when you make lifestyle interventions), your A1c may become as low as 4.5, which equates to an *average* blood sugar of 83 mg/dl. To put this in context, consider that when you're glucose adapted, it's common for your blood sugar to be above 140 mg/dl for 1-2 hours after a carbohydrate meal—and to remain above 100 mg/dl for 3 (or more) hours following meals. Elevations in blood sugar such as these drive A1c readings increasingly skyward.

An A1c of 4.5 (average blood sugar of 83 mg/dl) means that your blood sugar rarely exceeds 90 mg/dl, even after meals. This explains why A1c readings in the 4.5 range are unheard of in glucose-adapted subjects, because post-meal blood sugar is almost always above 140 mg/dl for a few hours, and is above 100 mg/dl for several hours.

A1c values are markedly different for glucose- and fat-adapted subjects. When you're glucose-adapted, blood sugar and A1c readings will be *convergent*, meaning that if one goes up, so will the other. But as we'll see later in this section, blood sugar and A1c readings can become *divergent* once you're fat-adapted. This means that *some* of your blood sugar readings can appear elevated, but your A1c readings will be consistently lower. When divergence occurs,

which is common when you're burning fats and ketones, it becomes imperative to measure your hemoglobin A1c. The range of A1c values for both glucose- and fat-adapted subjects are shown in Table 4.

Table 4: Hemoglobin A1c Reference Ranges

	Healthy	Developing or Unhealed Metabolic Mayhem	Prediabetes	Diabetic
Glucose-adapted	4.5-5.3	5.4-5.6	5.7-6.4	≥6.5 (2 or more)
Fat-adapted	4.5-5.0	5.1-5.3	5.4-5.6	≥5.7

It's important not to turn your A1c readings into a competition. What's optimal for one person isn't what's optimal for another. If all of your biomarkers are optimized, there's no need to become fixated on lowering your A1c if it's already 5.0 or lower. (Or even 5.1-5.2) Increasing A1c readings are strongly associated with all-cause mortality[321].

Blood Sugar

Blood sugar is such a critical metabolic biomarker that an entire chapter has been devoted to how to measure and interpret it correctly. Unlike other biomarkers, blood sugar is easy to test throughout the day. In addition, normal blood sugar values are markedly different for glucose- and fat-adapted subjects. Blood sugar is summarized in this chapter; please refer to Blood Sugar: The Everyday Biomarker for in-depth information about this essential biomarker.

Triglycerides

Triglycerides are the fat in your blood. When your metabolism is healthy, triglyceride levels will *always* be within healthy limits when you carefully follow the Metabolic Masterplan Diet. However, as metabolic mayhem develops, triglyceride levels commonly become too high. Once triglyceride levels become elevated, it's practically impossible to bring them firmly within healthy limits until steps are taken to heal your metabolism. That's why triglycerides are a "go-to" metabolic biomarker that I rely on to accurately assess metabolism.

Recall that the liver converts excess blood sugar into fat via a process known as de novo lipogenesis. If too many carbs are consumed, or if the liver makes too much blood sugar (or if both occur, which is common), the liver will convert the blood sugar that your cells can't utilize into triglycerides. This is where things get interesting. Triglycerides are measured when you're fasting. If you have blood drawn at 8 a.m. and your last meal was at 7 p.m. the night before, you've been fasting for 13 hours. If your blood test indicates high triglycerides, it's not because you overate fat for dinner the night before. That fat was cleared from your blood hours before you gave blood. If your triglyceride levels are elevated on a fasting blood test, it's because your body produces too much blood sugar and converts it into fat. Elevated *fasting* triglycerides are a serious health issue that must be dealt with. I cannot emphasize this point strongly enough.

Most government and medical institutions, including the Centers for Disease Control and Prevention (CDC), state that triglyceride values lower than 150 mg/dl are healthy. This recommendation, however, is dangerously high. When your triglycerides are near 80 mg/dl on several consecutive blood tests—which is *highly unlikely* if you're glucose adapted—they're right where they need to be.

When metabolism heals and fat becomes your primary fuel, triglycerides become a rock-solid indicator of metabolic health. I prefer to see the amount of fat circulating in your blood to be within a highly optimized range, regardless of whether you're mainly burning blood sugar or primarily burning fat. Triglycerides are measured in a basic cholesterol test known as a *lipid profile*, and they're also measured in an NMR test. Triglyceride levels above 90 mg/dl are associated with all-cause mortality[322].

Triglyceride Reference Range:

- 75-85 mg/dl — Healthy
- 86-99 mg/dl — Moderate metabolic mayhem
- ≥100 mg/dl — Advanced metabolic mayhem

LDL Cholesterol (LDL-C)

LDL, which stands for low-density lipoprotein, is a hotly debated and much-maligned cholesterol value. Contrary to what we've been (mis)led to believe, LDL cholesterol isn't bad. In fact, *low* LDL cholesterol is inexorably associated with an increased risk of heart attacks. LDL cholesterol (LDL-C) is the amount of cholesterol in LDL *particles*. LDL particles (LDL-P) are the particles that carry LDL cholesterol. LDL-C and LDL-P *are not the same things*. By assessing LDL cholesterol (LDL-C), LDL particles (LDL-P) and the *size* of the LDL particles, a great deal of information can be gained about your metabolic health and risk status for developing cardiovascular disease.

I only assess LDL cholesterol values within the context of other metabolic biomarkers. Furthermore, I look for very different HDL-C readings based on whether a patient is glucose- or fat-adapted. This is because it's impossible to assess metabolic health by LDL-C alone. Healthy LDL cholesterol (LDL-C) values are commonly between 105-150 mg/dl *when metabolism is healed, fat is your primary fuel, and all other biomarkers are within or near optimal levels.* LDL-C between 105-150 mg/dl may seem high—and it may actually be high for glucose-adapted subjects—but this range isn't high when metabolism is healed and fat is efficiently burned.

I can't impress this point enough: LDL cholesterol must be assessed along with all other biomarkers to determine whether it's high, low or right. LDL-C values vary widely between glucose-adapted and fat-adapted subjects, and vary based on metabolic health. LDL cholesterol, LDL particles and LDL particle size are measured via an NMR test. These important metabolic biomarkers are explored in detail in the Cholesterol Section.

LDL-P (The Number of LDL Particles)

LDL-P stands for low-density lipoprotein *particles*. The greater the number of LDL particles (LDL-P) in your blood, the greater your risk of developing atherosclerosis (hardening of the arteries) and cardiovascular disease. LDL-P is the most prognostic indicator for assessing your risk of cardiovascular disease; unless you know LDL-P, i.e., the number of LDL particles in your blood, you don't know your risk status for developing atherosclerosis and cardiovascular disease. LDL-P is commonly measured via a nuclear magnetic resonance (NMR) test. It's strongly recommended that you measure LDL-P before, during and after switching to the Metabolic Masterplan Diet to ensure this critical biomarker is within healthy limits.

It isn't easy to appreciably nudge LDL-P in the right direction through dietary means when following a carbohydrate-based diet. But that being said, not everyone who switches to a fat-based diet sees improvement in their LDL-P. Some patients experience a *worsening* of their LDL-P when they convert to a fat-based diet. Only by measuring LDL-P can you be sure that the changes you're making are positively affecting your risk status for the development of cardiovascular disease—the leading cause of death in today's world.

If LDL-P increases when you switch to the Metabolic Masterplan Diet, it's necessary to decrease your intake of saturated fat (heavy cream, butter, cheese) and increase your intake of monounsaturated fats (olive and avocado oil). Some patients find that replacing 5% of their saturated fat intake with monounsaturated fats is enough to drive their LDL-P in the right direction. However, others must replace 15-20% of their saturated fat intake with monounsaturated fats like olive and avocado oil before their LDL-P becomes optimized. Replacing 15-20% of your saturated fat intake with monounsaturated fats is easily accomplished by cooking your meals and dressing your salads in olive and avocado oil, and slightly cutting back on your intake of saturated fats.

Elevated LDL-P levels won't interfere with the liver's production of ketones, nor will high LDL-P interfere with fat burning. However, elevated LDL-P strongly indicates the need to heal your metabolism or change your diet, regardless of whether you're fat- or glucose-adapted. LDL-P is worsened by metabolic mayhem and improved by exercise and stress reduction, which is why it's so important to make lifestyle interventions.

How to Interpret LDL Particles (LDL-P):

- <1000 Ideal—very low risk
- 1000-1200 Low risk
- 1201-1500 Moderate risk
- 1501-2000 High risk
- >2000 Very high risk

My experience has taught me not to take for granted that a patient's LDL-P is optimized because their metabolism is healed and they're consuming all the right fats. It's only after a patient's LDL-P has consistently been within healthy limits for about a year that I'm confident that things are going well and they're firmly on the path to optimization.

LDL Particle Size

The number of LDL particles (LDL-P) is the most prognostic of all cardiovascular indicators, but the *size* of the LDL particles in your blood matters, too. When LDL-P is measured via an NMR test, detailed information about the size of your LDL particles is provided. By assessing LDL cholesterol (LDL-C), LDL particles (LDL-P) and LDL particle size, a great deal can be learned about your metabolism. *Large* LDL particles are associated with metabolic optimization, whereas *smaller* LDL particles are associated with metabolic mayhem.

How to Interpret LDL Particle Size:

- More large and fewer small LDL particles are associated with decreased cardiovascular risk
- More small and fewer large LDL particles are associated with increased cardiovascular risk

HDL Cholesterol (HDL-C)

HDL cholesterol (HDL-C) has been long touted as "good cholesterol," but this is a bit overblown. High levels of HDL-C are healthful, but they aren't as cardioprotective as once thought. As with LDL cholesterol, the number of HDL particles (HDL-P) is more helpful for assessing cardiovascular health than the amount of HDL cholesterol (HDL-C). Healthy HDL-C values are ≥90 for women and≥80 for men. HDL-C is commonly measured on a standard lipid profile test.

Table 5: HDL-C Reference Ranges

Risk	Females	Males
Low	≥90 mg/dl	≥80 mg/dl
Moderate	50-89 mg/dl	49-79 mg/dl
High	<50 mg/dl	<45 mg/dl

HDL-P (The Number Of HDL Particles)

HDL-P stands for high-density lipoprotein *particles*. HDL-P is the number of high-density lipoprotein (HDL) particles circulating in your blood. HDL-P is not the same as HDL cholesterol (HDL-C). Whereas high levels of LDL particles are associated with increased risks of developing cardiovascular disease, high numbers of HDL particles are typically associated with lower cardiovascular risk. The number of HDL particles in your blood provides more information about your metabolism than HDL cholesterol. HDL-P is assessed via an NMR test.

HDL Particle Size

The size of the HDL particles in your blood provides valuable insight into your metabolism. Larger HDL particles are associated with a decreased risk of developing cardiovascular disease, and smaller HDL particles are associated with a greater risk. As your metabolism heals, your HDL particles are likely to be larger. HDL particle size is assessed via an NMR test.

How to Interpret HDL Particle Size:

- More large and fewer small HDL particles are associated with decreased cardiovascular risk
- More small and fewer large HDL particles are associated with increased cardiovascular risk

VLDL Cholesterol (VLDL-C)

VLDL, which stands for very low-density lipoprotein, are short-lived lipoprotein molecules that transport triglycerides and cholesterol in the blood. The VLDL value on a standard lipid profile is estimated by dividing triglycerides by 5. For example, if the triglycerides on your lab results are 100, your VLDL is estimated as 100 ÷ 5 = 20. This estimation is reasonably accurate for glucose-adapted subjects but inaccurate when fat becomes the primary fuel your cells rely on to create ATP. VLDL cholesterol values between 15-17 are excellent; values between 18-20 indicate the presence of metabolic mayhem, and values above 21 indicate that metabolic mayhem is becoming advanced.

How to Interpret VLDL Cholesterol Values:

- 15-17 Healthy
- 18-20 Moderate metabolic mayhem
- ≥21 Advanced metabolic mayhem

VLDL-P (the Number Of VLDL Particles)

As metabolic mayhem worsens, the number of VLDL particles produced by the liver increases. As this happens, triglyceride levels increase, LDL-P increases, and HDL-C decreases. Curiously, however, LDL-C, which is often scapegoated as the cause of cardiovascular disease, can remain unaffected *and fall within established healthy limits* as metabolic mayhem progressively worsens. This demonstrates the importance of assessing biomarkers as a whole, not separate entities. In general terms, fewer VLDL-P is associated with reduced cardiovascular risk. VLDL-P isn't evaluated on a standard lipid profile; basic information about VLDL-P is provided on the NMR test.

How to Interpret VLDL Particles (VLDL-P):

- Fewer VLDL-P is associated with decreased cardiovascular risk
- More VLDL-P is associated with increased cardiovascular risk

VLDL Particle Size

Smaller VLDL particles are associated with a reduced risk of cardiovascular disease, and larger VLDL particles are associated with an increased risk. VLDL-P isn't assessed on a standard lipid profile; basic information about VLDL-P is provided on the NMR test.

How to Interpret VLDL Particle (VLDL-P) Size:

- Smaller VLDL particles are associated with reduced cardiovascular risk
- Larger VLDL particles are associated with increased cardiovascular risk

The Triglyceride/HDL Ratio

By dividing the triglycerides on your lab reports by HDL cholesterol (HDL-C), you'll arrive at your TG/HDL ratio. For example, if your triglycerides are 125 and your HDL-C is 60, your TG/HDL-C ratio is 125 ÷ 60 = 2.08. Mainstream practitioners consider a ratio under five healthy, but I like to see this ratio at or below 1 when metabolism is healed. Most clients have triglycerides around 80 and HDL above 80, typically resulting in a TG/HDL ratio near 1.

If the TG/HDL ratio climbs above 1 (especially above 1.17), I suspect that metabolic mayhem has yet to fully heal, or that some dietary tightening up is required. A TG/HDL ratio above 1 may also be caused by too much stress and insufficient exercise. A triglyceride/HDL ratio in the neighborhood of 1 is practically unachievable when blood sugar is your primary fuel source, but is common when your metabolism is healed and fat is your primary fuel. The triglyceride/HDL ratio provides instrumental insight into your metabolism.

The Triglyceride/HDL Ratio Reference Range:

- ≤1.0 Healthy
- 1.01-1.1 Low metabolic mayhem
- 1.18-1.25 Moderate metabolic mayhem
- ≥1.26 Advanced metabolic mayhem

The Cholesterol/HDL Ratio

Some labs calculate your cholesterol/HDL ratio, while others don't. If your labs don't contain the cholesterol ratio, it's super easy to figure out. The cholesterol ratio is calculated by dividing the total amount of cholesterol on your lab reports by HDL-C. For example, if your total cholesterol is 255 and your HDL-C is 52, your cholesterol ratio is 255 ÷ 52 = 4.9. A cholesterol ratio that's less than five is considered to be healthy by government and medical institutions, and a ratio below 3.5 is considered optimal. Even so, I prefer the cholesterol ratio to be between 2.5 and 3.0. This is because higher cholesterol ratios are associated with an increased risk for cardiovascular disease. Please refer to the Cholesterol Section for more insight into the cholesterol ratio.

The Cholesterol/HDL Ratio Reference Range:

- 2.5-3.0 Healthy
- 3.1.3.5 Moderate metabolic mayhem
- ≥3.6 Advanced metabolic mayhem

Ox-LDL (Oxidized LDL Cholesterol)

Elevated ox-LDL levels are a natural consequence of metabolic mayhem. Increasing ox-LDL levels are inseparable from metabolic syndrome, prediabetes, insulin resistance, hyperinsulinemia and type 2 diabetes. Elevated ox-LDL levels are also common in kidney disease, polycystic ovarian syndrome and hypothyroidism. Unlike Lp(a) levels, which don't appreciably change in response to lifestyle modifications like exercise and dietary improvements, ox-LDL levels can be significantly improved by healing your metabolism, balancing your omega 3:6 ratio and switching to a fat-based diet. Importantly, elevated ox-LDL levels are strongly linked to excess consumption of linoleic acid, a highly proinflammatory omega-6 oil. Ox-LDL is covered in much greater detail in the Cholesterol Section. Ox-LDL is measured via a blood test.

Ox-LDL Reference Ranges:

- Low risk: Below 60 ul/L
- Moderate risk: 60-69 ul/L
- High risk: ≥70 ul/L

Lp(a)

Lp(a) is a powerful proinflammatory LDL-like particle. Lp(a) is so atherosclerotic that elevated Lp(a) levels are an independent risk factor for atherosclerosis and cardiovascular disease development. The current scientific opinion is that Lp(a) levels are genetically mediated and cannot be appreciably changed by dietary and other lifestyle interventions. But as linoleic acid levels are brought within healthy limits (linoleic acid is a proinflammatory omega-6 oil common to the Western diet), Ox-LDL levels drop, which may, in turn, reduce Lp(a) levels.

Similar to standard blood tests that measure LDL cholesterol, most Lp(a) tests measure the amount of Lp(a) contained in your Lp(a) particles, and not the number and size of the particles themselves. Also similar to LDL, knowing the number of Lp(a) particles is far more helpful than knowing the amount of Lp(a) in your Lp(a) particles. Testing for both Lp(a)-P (the number of Lp(a) particles) and the concentration of Lp(a), i.e., Lp(a)-C, provides the most helpful information.

Lab tests that measure the *mass* of Lp(a) are expressed in milligrams per deciliter (mg/dl), and Lp(a) tests that measure Lp(a) *particles* are expressed in nanomoles per liter (nmol/L). Tests that measure Lp(a) mass aren't as helpful as those that measure the number of Lp(a) particles. Healthy reference ranges for Lp(a) mass and Lp(a) particle tests are still being developed, but the following guidelines are a good approximation of Lp(a) mass and particle test results. Lp(a) is pronounced *L P little A*.

Table 6: Lp(a) Reference Ranges

Risk	Lp(a) Mass (mg/dl)	Lp(a) Particles (nmol/L)
Low	5-29 mg/dl	13-73 nmol/L
Moderate	30-49 mg/dl	73-124 nmol/L
High	>50 mg/dl	>125 nmol/L

If your Lp(a) levels are high, it's essential to do everything you can to bring them as close to optimal levels as possible. By now, the formula for doing so has become familiar:

- Make wise dietary choices.
- Keep your stress levels in check.
- Get plenty of exercise.
- Heal chronic inflammation.
- Heal your gut.
- Optimize your thyroid function and detoxify your body.

If you're doing everything within your power to optimize your health and your Lp(a) levels don't appreciably change, don't stress about it. Not everyone's Lp(a) levels will become optimized when they take consistent action to optimize their health. If you're taking as much action as possible and your Lp(a) levels remain elevated, know that you're controlling everything that can be controlled and that there's no point in worrying about the rest.

The apoB/apoA-I Ratio

Several lipoprotein particles contain a protein known as apoB. These include chylomicrons, VLDL, IDL, LDL and Lp(a). Conversely, HDL particles contain apoA-I. To calculate the apoB/apoA-I ratio, the total number of particles containing apoB are added together and divided by the total particles containing ApoA-I. Cardiovascular risks become more significant as the number of apoB particles increases and apoA-I particles decrease. The apoB/apoA-I ratio is much more prognostic of adverse cardiac events, i.e., heart attacks and strokes, than commonly measured metabolic biomarkers, including LDL and total cholesterol.

A typical cholesterol blood test, i.e., a lipid profile, doesn't measure all of the apoB particles in your blood, but the apoB/apoA-I test does. An apoB/apoA-I test can be performed by most labs. An unhealthy apoB/apoA-I ratio doesn't interfere with fat burning. Still, it strongly indicates metabolic mayhem, increased risk of adverse cardiac events, and the need for lifestyle interventions.

Table 7: Risk of Heart Attack Based on apoB/apoA-I Ratio

Gender	Low Risk	Moderate Risk	High Risk
Males	0.40-0.69	0.70-0.89	0.90-1.10
Females	0.30-0.59	0.60-0.79	0.80-1.0

Total Cholesterol

Total cholesterol is the subject of ongoing debate. Medicine places significant emphasis on cholesterol values, though much of this emphasis is dogmatic, misguided, and designed to sell drugs of dubious benefit. Doctors berate patients into taking medications to lower their cholesterol; however, the fact of the matter is that most doctors don't know the facts about cholesterol. One of the largest studies performed on cholesterol, the Framingham Heart Study, clearly determined that total cholesterol levels only correlate with cardiovascular disease when they're above 380 or below 150 mg/dl[323]. In other words, total cholesterol between 150 mg/dl and 380 mg/dl is the de facto normal range, and readings within this range do not correlate with the development of cardiovascular disease. Total cholesterol must be assessed within the context of all other metabolic biomarkers and cannot be meaningfully interpreted as a standalone biomarker.

Insulin

As your metabolism heals and fat becomes your primary fuel, insulin levels will remain surprisingly low at all times, even after meals. This is extremely important because high insulin levels are associated with a laundry list of diseases, including diabetes, obesity and cancer[324, 325], as well as all-cause mortality, increased aging and decreased longevity[326, 327, 328]. Fasting insulin levels for healthy fat-adapted individuals (no food for at least 10 hours) are ≤4 uIU/mL. For comparison, fasting insulin levels above 30 uIU/mL are typical when metabolic mayhem is advanced.

Fasting Insulin Reference Ranges:

- ≤4 uIU/mL Healthy
- 5-7 uIU/mL Moderate metabolic mayhem
- ≥8 uIU/mL Advanced metabolic mayhem

The Omega 3:6 Ratio

Omega-3s and omega-6s are specific fats in the human diet. In the mid-1800s, humans began consuming more omega-6 oils and fewer omega-3s. This has led to an imbalance in the omega 3:6 ratio characterized by an overabundance of omega-6 fats and too few omega-3 fats in the body. This imbalance powerfully contributes to chronic inflammation, metabolic mayhem and all chronic diseases. A healthy omega 3:6 ratio is between 1 and 2.5. For more information on the omega 3:6 ratio, please refer to the Core Essentials and Chronic Inflammation Sections. The omega 3:6 ratio is measured via a blood test.

Omega 3:6 Reference Ranges:

- 1:2.5 Healthy
- 1:2.6-5.0 Chronic inflammation is developing
- 1:5 High degree of chronic inflammation exists

Adiponectin

Adiponectin is an adipokine that's secreted by fat cells. Since adiponectin controls insulin sensitivity, i.e., how sensitive your cells are to the effects of insulin, it's been dubbed the master regulatory hormone of metabolism. As fat stores increase, adiponectin levels decrease, and adiponectin cannot control metabolism. This is a real catch-22, because the only way to increase adiponectin levels is by reducing fat stores, and once adiponectin levels drop, burning fat can be a big challenge. Through careful attention to diet, fat stores are normalized, which in turn allows adiponectin levels to head in the right direction.

Adiponectin levels vary based on age and sex, and are also affected by pregnancy. Due to these limitations, I don't rely on adiponectin as a frontline metabolic biomarker when assessing metabolic health. If you have adiponectin tested, compare current results to those taken in the past to determine if your metabolism is healing.

Leptin

Like adiponectin, leptin is an adipokine. As fat stores increase, leptin secretions also increase. Excess leptin secretions lead to *leptin resistance*, which causes the brain to pay less attention to this metabolism-regulating hormone. Leptin controls the hunger signal, and as fat stores and leptin levels increase, it becomes increasingly difficult to control your food intake.

Leptin levels vary greatly based on metabolic health, sex, racial differences, alcohol consumption, cigarette smoking and diet. These variables make it difficult to determine if your leptin levels are healthy by comparing your results against standard reference ranges for leptin. For these reasons, I don't rely on leptin as a metabolic biomarker. If you have leptin tested, compare your current results to those taken in the past to determine if your metabolism is healing.

Adiponectin/Leptin Ratio

Whereas assessing adiponectin and leptin as individual biomarkers isn't a foolproof means of determining what's taking place with your metabolism, the adiponectin/leptin ratio is an emerging biomarker that provides excellent insight into metabolism. The adiponectin/leptin ratio is derived by dividing adiponectin by leptin. Low adiponectin/leptin ratios are strongly associated with obesity, chronic inflammation, insulin resistance and metabolic syndrome.

Adiponectin/Leptin Ratio Reference Range:

- Healthy ≥ 1.0
- Moderate risk between 0.5 and 1.0
- High risk <0.5

Source: [329]

Body Fat Stores

Body fat includes abdominal (visceral), android and gynoid fat stores. An excess of any of these fat stores can strongly disrupt the delicate balance of metabolism by altering adiponectin, leptin, triglyceride and proinflammatory cytokine levels. Fat stores can be measured with a body scan such as a DEXA scan. However, the easiest way to assess body fat is by looking in the mirror and honestly evaluating how your body fat changes over time. I recommend having pictures taken of you from the front, sides and back every two weeks. Then, as weeks turn into months and your metabolism heals, you'll be pleasantly surprised by how your fat stores diminish when you make lifestyle interventions.

If you're trying to lose weight and are diligent with your food consumption, you'll shed about a pound of fat per week (you'll lose considerably more fat if you're fasting or calorie-restricting). You may shed more than a pound of water weight per day, especially when you initially restrict calories, but fat stores are depleted more slowly than water. One pound of fat contains just over 3,600 calories. If you burn 100 calories of your fat stores daily, losing one pound of fat will take 36 days. If you burn 500 calories of your body's fat stores daily for a week, you'll burn about a pound of fat

per week. If you burn 1,000 calories of your fat stores daily for a week, you'll burn about two pounds of fat per week. This gives you a realistic gauge for quickly you can expect to burn through your fat stores when you restrict your intake of calories.

Ectopic Fat Stores

As metabolic mayhem advances, ectopic fat stores increase in the liver, skeletal muscles, pancreas, heart and other organs, *even in lean subjects*. Ectopic fat accumulations in the liver and other organs are measured via ultrasound, while skeletal muscle ectopic fat is measured via DEXA scan. The data on ectopic fat accumulations throughout the body are robust. However, specific percentages and their associated risk for developing diseases, e.g., cardiovascular disease, are still being determined for organs such as the heart. Table 8 shows the percentage of ectopic fat accumulation in the liver, skeletal muscles and pancreas and the risk they convey for developing diseases.

Table 8: Risk Status of Ectopic Fat Accumulation in Organs

Organ	Low Risk	Moderate Risk	High Risk
Liver	3.66%	5.88%	8.26%
Muscles	5.25%	7.56%	10.93%
Pancreas	5.98%	9.36%	11.69%

Source: [330]

Homocysteine

Homocysteine is a crucial biomarker used to assess many functions, especially *methylation*. Methylation, which is reviewed in the Supplements, Vitamins, Minerals, Essential Micronutrients and Digestive Aids Section, is the vital process of adding *methyl groups* to countless molecules in your body. Many factors can cause homocysteine levels to rise. These include deficiencies in vitamins B6, B9 and B12, and single nucleotide polymorphisms that impair the MTHFR (methylenetetrahydrofolate reductase) gene.

Homocysteine Reference Range:

- Healthy ≤7 nmol/ml
- Moderate risk 8-10 nmol/ml
- High Risk ≥11 nmol/ml

Methylmalonic Acid (MMA)

When your cells don't have enough vitamin B12, *methylmalonic acid (MMA)* levels increase in the blood and urine. Homocysteine also increases in the blood in the presence of vitamin B12 deficiency. Thus if MMA and homocysteine levels increase—*regardless of the amount of vitamin B12 measured in the blood*—a vitamin B12 deficiency is possible. Elevated serum homocysteine levels occur in response to many conditions, not just B12 deficiencies. Thus elevated homocysteine levels may indicate B12 deficiency, whereas elevated MMA levels strongly suggest a B12 deficiency. Urine MMA levels yield more accurate results than measuring MMA in the blood.

Methylmalonic Acid Reference Range:

- Healthy 0.4 – 2.5 µmol/mmol crt (micromoles per mmol of creatinine measured in the urine)

Vitamin D3

Vitamin D deficiency is widespread in the modern world, and is associated with many health issues, including cancer. Liver is the only food that contains enough vitamin D to meet your needs for this essential micronutrient. Direct exposure to unfiltered midday summer sun is unquestionably the best way for humans to get the vitamin D they require, but many avoid such exposure due to skin cancer concerns. The lack of reliable dietary sources of vitamin D and sun avoidance combine to make vitamin D supplementation necessary. Please refer to the Supplements, Vitamins, Minerals, Essential Micronutrients and Digestive Aids Section for a review of this important vitamin.

Vitamin D3 Reference Range:

- Healthy 40-60 ng/mL

Lp-PLA2 (Lipoprotein-associated phospholipase A2)

Phospholipases are a family of important chemicals that create fats in the body. Chronic inflammation leads to the overexpression of Lp-PLA2, which in turn is associated with atherosclerosis, blood vessel rupture, heart attacks, strokes, and a greater risk of cardiac and cerebrovascular events. Importantly, Lp-PLA2 is a far more predictive biomarker for heart disease than LDL and HDL cholesterol. Lp-PLA2 is contained in atherosclerotic plaques that form within the walls of arteries.

Lp-PLA2 Reference Range:

- Healthy ≤200 ng/mL
- Moderate risk 200-225 ng/mL
- High risk ≥225 ng/mL

Resting Heart Rate

Well-developed cardiovascular fitness lowers cardiovascular disease risks, reduces blood pressure, improves insulin sensitivity, and improves cholesterol and triglycerides profiles. In addition, well-developed cardiovascular fitness lowers your resting heart rate. A resting heart rate of ≤ 60 beats per minute reduces all-cause mortality, increases lifespan, longevity and healthy aging. X-rays and biomarkers don't tell lies, nor does your resting heart rate. If you truly desire to be healthy past 100, maintaining a resting heart rate of ≤ 60 beats per minute is crucially important.

Resting Heart Rate Reference Range:

Healthy	≤ 60 beats per minute
Moderate risk	61-72 beats per minute
High risk	≥ 73 beats per minute

Interpreting Your Metabolic Biomarkers

We started this chapter by asking how to know if metabolic mayhem has developed, and the answer to this question is, of course, *by measuring metabolic biomarkers*. If it weren't for metabolic biomarkers, knowing what's going on with all aspects of your metabolism would be a guessing game at best. But by measuring key metabolic biomarkers, you'll be able to determine, with great accuracy, the following crucial points:

- If you've developed metabolic mayhem
- How advanced metabolic mayhem has become
- If the actions steps you're taking to heal it are working
- If your metabolism is healthy enough to safely switch to a fat-based diet
- If your metabolism has become optimized
- If you've lowered your risk for developing diseases like diabetes and cardiovascular disease

Biomarkers don't lie. They really are the metabolic polygraph tests that will tell you the truth about your metabolism. Metabolic biomarkers provide such penetrating insight into your metabolism that you'll rely on them to guide you through the process of switching to the Metabolic Masterplan Diet. So if you're ready to guide your healthcare choices with the best information on the planet, my advice is to run, not walk to the nearest lab and get your metabolic biomarkers tested.

Table 9 contains fasting (where applicable) reference ranges for *healthy metabolism* (Column A), *moderate metabolic mayhem* (Column B), and *advanced metabolic mayhem* (Column C). When your metabolism is healed *and* you're burning fats and ketones, most of your metabolic biomarkers will fall within Column A. If several of your metabolic biomarkers fall within Column B, it strongly indicates your metabolism is still healing. If several of your biomarkers fall within Column C, you're likely dealing with advanced metabolic mayhem.

Even if you searched high and low and near and far, it would be challenging to come up with the reference ranges in Table 9. Some of these reference ranges have been adapted from scientific literature, some are based on my clinical

experience, some can only be determined within the context of other biomarkers, and some biomarkers are difficult to assess with reference ranges because they vary greatly based on age, race, sex, metabolic health, alcohol consumption, smoking and other factors, making them impractical for use outside of tightly controlled environments.

The reference ranges in Table 9 are your guide to interpreting your lab results. You'll refer to this table over and over again while you're in the process of healing and optimizing your metabolism. When combined with the reference ranges for blood sugar, which are explored in detail in the next chapter, you'll have rock-solid guidelines for assessing your metabolic health. Please note that the reference ranges in Table 9 do not match conventional reference ranges. If some of your lab values fall outside of normal reference ranges once your metabolism heals (this is likely), it's recommended that you work with a healthcare provider who can think outside the reference range.

Table 9: Fasting Reference Ranges for Metabolic Biomarkers

Metabolic Biomarker	Column A Healthy Metabolism	Column B Moderate Metabolic Mayhem	Column C Advanced Metabolic Mayhem
Hemoglobin A1c (fat-adapted)	4.5-5.0	5.1-5.3	5.4 and above
Hemoglobin A1c (glucose-adapted)	4.5-5.3	5.4-5.6	5.7 and above
Triglycerides	75-85 mg/dl	86-99 mg/dl	100 mg/dl and above
Triglyceride/HDL ratio	≤1.17 (≤1 is optimal)	1.18-2.0	2.1 and above
Blood sugar	See Blood Sugar Section	See Blood Sugar Section	See Blood Sugar Section
LDL-C (LDL cholesterol)	Case by case	Case by case	Case by case
LDL-P (number of LDL particles)	≤1200 (<1000 is ideal)	1201-1500	≥1501
LDL particle size	Large particles	Medium particles	Small particles
HDL-C (HDL cholesterol)	≥90 women ≥80 men	50-89 women 45-79 men	<50 women <45 men
HDL-P (number of HDL particles)	More large, few small	Mix of large and small	More small less large
HDL particle size	Larger particles	Medium particles	Small particles
VLDL-C (VLDL cholesterol)	≤17	18-20	≥21
VLDL-P (number of VLDL particles)	Fewer particles	Moderate particles	More particles
VLDL particle size	Smaller particles	More large particles	Larger particles
Cholesterol/HDL ratio	2.5-3.0	3.1-3.5	≥3.6
Lp(a) mass	5-29 mg/dl	30-49 mg/dl	> 50 mg/dl
Lp(a) particles	13-73 nmol/L	74-124 nmol/L	>125 nmol/L
The apoB/apoA-I ratio (males)	0.40-0.69	0.70-0.89	0.90-1.10
The apoB/apoA-I ratio (females)	0.30-0.59	0.60-0.79	0.80-1.0
Ox-LDL	Below 60 ul/L	60-69 ul/L	≥70 ul/L
Total cholesterol	Case by case	Case by case	Case by case
Insulin	≤4 uIU/mL	Between 5-7 uIU/mL	≥8 uIU/mL
Omega 3:6 ratio	1.0-2.5	2.6-5.0	≥5.0
Adiponectin	Case by case	Case by case	Case by case
Leptin	Case by case	Case by case	Case by case
Adiponectin/leptin ratio	≥1.0	0.5-0.9	≤0.5
Body fat stores	Minimal	Moderate	Obese
Ectopic fat (liver)	≤3.7%	3.8-5.8%	>5.9%
Homocysteine	≤7 nmol/ml	8-10 nmol/ml	≥11 nmol/ml
Methylmalonic acid (urine)	0.4 – 2.5 µmol/mmol crt		
Vitamin D	40-60 ng/mL	<40 ng/mL	<40 ng/mL
Lp-PLA2	≤200 ng/mL	200-225 ng/mL	≥225 ng/mL
Resting heart rate	≤ 60 beats per minute	61-72 beats per minute	≥ 73 beats per minute

The Whole Is Greater Than the Sum of Its Parts—Especially Regarding Cholesterol Biomarkers

Metabolic biomarkers must be interpreted as a whole and not as individual parts. LDL-C, a commonly misunderstood metabolic biomarker, is an excellent example of why this is so. Let's say that your triglycerides, triglyceride/HDL ratio, A1c, HDL-C, HDL-P, HDL particle size, LDL-P and insulin all fall within Column A (healthy metabolism), *and* your LDL-C hovers around 140 mg/dl (a figure that most doctors have been trained to believe is dangerously high, but is perfectly healthy when your metabolism is healed and you're burning fats and ketones). If this is the case, 140 mg/dl is likely *a healthy LDL-C biomarker for you*. If your other metabolic biomarkers are healthy, there's no need to force LDL-C into a "healthy" reference range, even if your doctor, coworkers, spouse or the internet suggests you need to do so. Attempting to improve biomarkers that are already optimized is the stuff of madness. This fruitless pursuit will not only drive you crazy but also detract from your health.

On the other hand, if several of your metabolic biomarkers fall into Columns B and C, indicating the presence of metabolic mayhem, it's possible and even likely that LDL-C of 140 mg/dl is an unhealthy biomarker. When it comes to biomarkers, especially when it comes to commonly misunderstood biomarkers such as LDL-C and total cholesterol, it's all about context. Suppose several of your biomarkers indicate the presence of metabolic mayhem. In that case, biomarkers such as LDL-C and total cholesterol are more likely to indicate metabolic mayhem. So long as several of your metabolic biomarkers fall within Columns B and C, place your focus steadfastly on healing your metabolism, not on modifying particular metabolic biomarkers.

This point is so crucial that it bears repeating: don't focus on improving individual metabolic biomarkers, e.g., LDL-C. Instead, focus on healing your metabolism, dialing in your diet, healing your gut, eliminating chronic inflammation, getting plenty of exercise and destressing. By focusing on what you can change, most of your biomarkers will begin to fall within Column A. As this happens, it will become clear if some of your biomarkers require specific attention. But until your metabolism heals and most of your biomarkers fall within the reference ranges in Column A, fixating on individual biomarkers will leave you dizzier than a dog chasing its tail.

Metabolic Biomarkers Spontaneously Optimize When Metabolism Is Healed

As your metabolism heals and you become fat-adapted, you'll be pleasantly surprised to find that most of your biomarkers will naturally and spontaneously fall within the healthy reference ranges in Column A. Many patients are blown away when the metabolic biomarkers they've been stressed over and struggling to improve suddenly fall within the healthiest 1% of all humans on the planet as their metabolism becomes optimized.

Optimized metabolic biomarkers are the factual data proving to you and anyone else that your lifestyle changes are working. When your labs plainly show that you're healthier than 99% of all humans on the planet, you'll experience the peace of mind that can only develop when all doubt is removed about whether or not your diet (and your lifestyle per se) is putting you at risk for developing chronic diseases such as cancer, heart disease, diabetes and Alzheimer's, or reducing that risk.

When your labs are optimized and your risk for developing Western diseases is as low as humanly possible, arguments about whether vegetarian, vegan, Paleo or other dietary approaches are the best become meaningless. When your labs are superhumanly healthy, there's no guesswork and no fudging of figures. Having your metabolic biomarkers fall within the healthiest possible limits is pie in the sky when you're burning blood sugar—but it's another day at the office when you're a bonafide fat burner. Optimized metabolic biomarkers lead to miraculous metabolism, but unoptimized biomarkers are associated with metabolic syndrome and all-cause mortality[331].

Start With These Tests

If your budget is tight, start with an NMR (nuclear magnetic resonance) test and a hemoglobin A1c. As mentioned, these two tests cost about $150.00 combined, and will provide you with a great deal of information about your metabolism. With just these two tests, you can assess 13 metabolic biomarkers shown in Table 9. The NMR test is also known as a *lipoprotein subfraction test* or a *lipoprotein fractionation test*, depending on which lab is used. Be sure that the NMR test you order comes with a report that provides information about several of the biomarkers in Table 9, including the number and size of lipoprotein particles, e.g., HDL particles. It's strongly recommended that you run

these tests before switching to the Metabolic Masterplan Diet, because your test results are used to guide you through the transition to the MMD.

Start With These Tests:

- NMR (nuclear magnetic resonance)
- Hemoglobin A1c

These Tests Provide Additional Insight About Your Metabolism

By also including the following tests, you'll have a complete picture of what's taking place with your metabolism:

- Insulin
- Ox-LDL
- Lp(a)
- The omega 3:6 ratio
- Ectopic fat (assessed via a liver ultrasound)
- DEXA scan
- Homocysteine
- Methylmalonic acid (if indicated)
- Lp-PLA2
- Thyroid hormones (please see the Thyroid Physiology and Iodine Section)

If your budget allows, it's recommended that you also test for Ox-LDL, Lp(a) and the omega 3:6 ratio. A liver ultrasound will reveal the presence of fatty liver, and a DEXA scan provides insight into body fat stores. Unhealthy levels of Ox-LDL are strongly linked to the overconsumption of linoleic acid, a highly proinflammatory omega-6 oil. Although high levels of ox-LDL won't interfere with burning fats and ketones, measuring them can help you determine if your dietary changes are lowering your risk of developing cardiovascular disease. Lastly, measuring your insulin, homocysteine, Lp-PLA2 levels and thyroid hormones is also recommended if your budget allows it.

Note: there are many other biomarkers that provide insight into your overall health. *HP100* is thorough, but an in-depth analysis of blood chemistries is beyond the scope of this book.

How Often Is It Necessary to Re-Test Metabolic Biomarkers?

We'll review how often to re-test metabolic biomarkers in the coming chapters.

What's Next: The Yet-To-Be Introduced Metabolic Biomarker: Blood Sugar

One metabolic biomarker hasn't been reviewed, and it's arguably one of the most useful of all metabolic biomarkers: blood sugar. Of course, it's important to monitor as many metabolic biomarkers as possible, but blood sugar is the biomarker that you'll rely on most. Metabolic biomarkers such as triglycerides and cholesterol values require a blood draw at a lab and a lengthy wait for results, but you can check your blood sugar several times throughout the day and get immediate feedback about the state of your metabolism.

The insights gained by checking your blood sugar are so critical that I won't work with a client who isn't carefully monitoring their blood sugar. It's that important. With that introduction, let's turn our attention to blood sugar. After all the information we've covered about metabolic biomarkers, reading an entire chapter dedicated to blood sugar may seem like overkill. Still, I assure you that learning about blood sugar will teach you more about metabolism than you ever thought possible.

Chapter 11:
Blood Sugar—The Everyday Metabolic Biomarker

Annual Fasting Blood Sugar Results Can Be Misleading

Blood sugar is a key biomarker routinely tested in annual and other blood tests. But having your blood sugar checked once a year provides little insight into your metabolism. Concerningly, it's common for patients in full-blown metabolic mayhem to be told that their fasting blood sugar is healthy—and that they're healthy—when prediabetes or even type 2 diabetes is advancing.

Measuring fasting blood sugar once or twice a year provides little insight into your metabolic health. But when blood sugar is measured *at key points throughout the day*, it offers volumes of much-needed information about your metabolism that you won't find anywhere else. Blood sugar readings can reveal moderate or advanced metabolic mayhem that would have otherwise remained undetected. And unlike most metabolic biomarkers, checking your blood sugar doesn't require giving blood and waiting for test results. Instead, when you check your blood sugar at crucial points throughout the day, you get instant feedback about what's happening with your metabolism. This feedback is so essential that it would be difficult to heal your metabolism without it.

How Do You Know if You're Burning Fats and Ketones? *Check Your Blood Sugar!*

Another reason to check your blood sugar is that *it's the most reliable means of determining if you're burning fats and ketones*. When your mitochondria metabolize mainly fats and ketones, specific patterns emerge in your waking, post-meal, between-meal and pre-bed blood sugar readings that are a sure sign you're in fat-burning mode. Once these patterns emerge and your other metabolic biomarkers fall within optimal ranges, you'll have conclusive evidence that you're well on your way to healing and optimizing your metabolism and making ATP from fats and ketones. You'll then use these patterns to guide you through the process of switching to the Metabolic Masterplan Diet.

Monitoring your blood sugar isn't meant to replace other metabolic biomarkers like triglycerides and insulin. Instead, it's intended to be used alongside them to provide unparalleled insights into what's taking place with your metabolism on a day-to-day basis. When making significant changes to your diet, you need to know *right now* if those changes are helping to heal your metabolism or if they're compounding already existing health problems; blood sugar can provide you with this crucial insight throughout the day.

Purchase a Blood Glucose Meter

Monitoring your blood sugar is easy, affordable and surprisingly painless when you do it right. When combined with other metabolic biomarkers such as cholesterol and triglycerides, blood sugar becomes an incredibly helpful tool providing invaluable insight into your metabolism. If you want to know if a bone is broken, take x-rays. If you want to know what's going on with your metabolism throughout the day, check your blood sugar. Of course, once your metabolism is healed, it's unnecessary to continue closely monitoring your blood sugar. Even so, many patients continue to monitor their blood sugar for years after their metabolism heals for the peace of mind it provides.

If you don't have a blood glucose meter, you can purchase an inexpensive unit from your local drugstore, mega-retailer or an online source. I find that affordable kits that are less than $50 work just about as well as the pricier ones that can set you back several hundred dollars. When choosing a meter, make sure that the test strips it uses are reasonably priced, around $25.00 for 100 test strips. A blood glucose meter includes a glucometer, test strips, a lancing device and extra lances.

Begin Monitoring Your Blood Sugar *Before* Changing Your Diet

Begin monitoring your blood sugar at least 2-3 days *before making any changes to your diet*. The readings taken before changing your diet will be compared to those taken afterward. These readings will guide you through healing your metabolism and successfully converting to a fat-burning diet.

Monitor Your Blood Sugar at These Points Throughout the Day:

- Within five minutes of waking (waking blood sugar)
- 1, 2 and 3 hours after each meal (postprandial blood sugar) (pre-meal blood sugar)
- Immediately before lunch and dinner
- Before bed

Some people find it helpful to keep track of their blood sugar readings in a journal or spreadsheet. You don't have to write down your blood sugar readings (unless that's your preference), as your self-monitoring blood glucose kit will keep track of them for you. Many inexpensive kits will send your readings to your smartphone, tablet or computer, allowing you to analyze them more thoroughly.

Blood Sugar Reference Ranges

By now you're familiar with the importance of metabolic biomarkers and the reference ranges used to interpret them. However, we didn't review blood sugar and its reference ranges when we covered the other metabolic biomarkers; this is because blood sugar, which is checked several times per day, requires a deeper explanation than other biomarkers. So, with the preliminaries out of the way, let's begin our examination of this important metabolic biomarker.

Blood Sugar Reference Ranges Differ Between Glucose-Adapted and Fat-Adapted Subjects

The blood sugar reference ranges used today by government and medical institutions were developed as guidelines for glucose-adapted populations. However, glucose-adapted populations have very different blood sugar patterns than those who burn primarily fat and ketones. This makes relying on standard blood sugar guidelines impossible once fat becomes your primary fuel. As a result, different guidelines are required for glucose-adapted and fat-adapted populations.

If you're currently glucose adapted, use the reference ranges for glucose-adapted subjects. If you're already fat-adapted, use the fat-adapted reference ranges. Again, begin checking your blood sugar before making any changes to your diet, and according to the following schedule: within 5 minutes of waking, following meals, immediately before lunch and dinner, and before bed.

Note: blood sugar readings are affected by numerous factors, including your current state of health, activity level, diet, stress and the temperature of your immediate environment. These factors can complexify the process of arriving at accurate blood sugar readings. Therefore, these factors must be considered if your blood sugar readings are erratic.

Glucose-Adapted Blood Sugar Reference Ranges

Waking/Fasting Blood Sugar

It's imperative to check your blood sugar within 5 minutes of waking each day. Before you go to bed each night, put your self-monitoring blood glucose kit where you're sure to see it first thing in the morning. When you're glucose-adapted, waking blood sugar readings tend to increase as metabolic mayhem worsens. Waking blood sugar is commonly called *fasting blood sugar* or *fasting plasma glucose*. Unfortunately, the ranges for healthy waking/fasting blood sugar are notoriously loose, lulling tens of millions of Americans into a false sense of security that all is okay with their metabolism when serious health issues are looming or have already developed.

Overly broad reference ranges are downright dangerous. For example, it's well-known that fasting/waking blood sugar between 91-99 mg/dl is strongly associated with the onset of type 2 diabetes[332]. Yet, the US government and medical institutions suggest that fasting blood sugar readings below 100 mg/dl are perfectly healthy. The difference between 91-99 mg/dl and 100 mg/dl may not seem like a lot, but it's as different as night from the day when it comes to glucose-adapted waking blood sugar readings.

For these reasons, the fasting/waking blood sugar reference ranges I've included for glucose-adapted subjects aren't the ones you're likely to find in use by most government and medical institutions today. Government agencies and medical institutions may wish to lull you into disease and sickness by ignoring a mountain of scientific evidence about

blood sugar reference ranges; nevertheless, my job is to provide you with the information needed to be healthy past 100.

Accurate Waking/Fasting Blood Sugar Reference Ranges for Glucose-Adapted (Not Fat-Adapted) Populations:

- Healthy—below 85 mg/dl
- Insulin resistant—86 to 99 mg/dl
- Prediabetic—100 to 125 mg/dl
- Diabetic—126 mg/dl or above

When you're glucose-adapted, healthy waking blood sugar readings will be *consistently* below 85 mg/dl. If your waking readings are between 86-99 mg/dl, you're becoming insulin resistant. You're prediabetic if your fasting readings are between 100 and 125 mg/dl. If your fasting readings are above 126 mg/dl, you have diabetes.

Waking blood sugar readings provide penetrating insight into your metabolism, but only when you use the correct reference ranges! Furthermore, when you check your blood sugar following meals, you'll learn much more about your metabolism. For example, I work with many patients who appear fit and healthy but have unknowingly developed advanced and even extreme metabolic mayhem. It's not uncommon for normal-weight patients in their early 20s with no outward signs of metabolic mayhem to be shocked out of their wits when their between-meal blood sugar readings indicate that they've developed type 2 diabetes—a fact that they could not have discovered without monitoring their blood sugar throughout the day.

Post-Meal (Postprandial) Blood Sugar

Post-meal, a.k.a. *postprandial blood sugar*, is the blood sugar in your body following meals. Even if you don't eat sugar or carbs, your blood sugar will almost always increase after meals. Recall that bolus insulin is secreted after meals to inhibit the liver's blood sugar production (gluconeogenesis). When metabolism is healthy, bolus insulin secretions continue until the cells have taken up the sugars, carbohydrates and protein consumed. But as metabolic mayhem advances, the liver becomes increasingly insulin resistant, and postprandial blood sugar levels climb too high. As metabolic mayhem becomes highly advanced, postprandial blood sugar can become too high and remain elevated for extended periods. This phenomenon is common in people with waking/fasting blood sugar readings *within healthy ranges*.

Postprandial blood sugar is commonly checked 2 hours after meals. The National Institutes of Health (NIH) recommends 2-hour postprandial blood sugar readings below 140 mg/dl for glucose-dependent subjects. I've been hammering on the fact that government and medical blood sugar reference ranges are notoriously broad, and postprandial guidelines are no exception. A 2-hour postprandial blood sugar reading of 140 mg/dl indicates insulin resistance or prediabetes. A 1-hour postprandial blood sugar reading of 140 mg/dl is acceptable for glucose-adapted subjects, but 2-hour postprandial readings need to be below 125 mg/dl. If postprandial blood sugar readings remain above 100 mg/dl after 3 hours, insulin resistance or prediabetes is developing (or already exists).

Postprandial Blood Sugar Reference Ranges for Glucose-Adapted (Non-Fat Burning) Subjects:

- 1-hour: below 140 mg/dl
- 2-hour: below 120 mg/dl
- 3-hour: below 85 mg/dl

You're not developing insulin resistance or prediabetes if your postprandial blood sugar readings are consistently within these ranges after carbohydrate meals. On the other hand, if some of your readings are at or above these figures, blood sugar and metabolic issues are developing, *even if your fasting blood sugar readings are normal*. The higher that postprandial blood sugar rises and the longer it takes to return to healthy limits, the more likely it is that metabolic mayhem is developing or has developed.

Like all blood sugar readings, postprandial blood sugar is affected by the number of macronutrients consumed, fiber intake, exercise, stress, caffeine, alcohol, and the health of your metabolism. In addition, what you consumed in your

previous meals also affects postprandial blood sugar. For example, consuming a large dinner on the heels of a large lunch and breakfast will increase postprandial blood sugar readings. Conversely, postprandial readings will be lower if you consume a small dinner following a light lunch. Postprandial blood sugar readings are markedly different for ketoadapted subjects, and are discussed later in this section.

Pre-Meal Blood Sugar

Checking your blood sugar just before lunch or dinner can provide valuable insights into your metabolism. For example, let's say you have breakfast at 8 a.m. and lunch at 1 p.m. If your blood sugar just before lunch, which was 5 hours later in this case, is still above 85 mg/dl, metabolic mayhem is likely developing. Conversely, if it's *below* 70 mg/dl, excess insulin may be causing low blood sugar, i.e., hypoglycemia. Thus healthy pre-meal blood sugar is between 70-85 mg/dl.

If your blood sugar remains elevated several hours after your previous meal, the meal you're about to consume will cause your blood sugar to remain elevated for several hours more. This causes chronically elevated blood sugar; elevated blood sugar is synonymous with insulin resistance and prediabetes, which commonly progresses into type 2 diabetes. Snacking between meals affects blood sugar readings taken immediately before your next meal. If pre-meal readings are high, reducing or eliminating snacking is essential. If pre-meal readings are low and you've snacked between meals, it's likely that hypoglycemia (low blood sugar) is developing, which is a severe consequence of metabolic mayhem.

Pre-Meal Blood Sugar Reference Ranges for *Glucose-Adapted* Subjects:

- Healthy—70 to 85 mg/dl
- Insulin resistant—86 to 99 mg/dl
- Prediabetic—100 to 125 mg/dl
- Diabetic—126 mg/dl or above

Pre-Bed Blood Sugar Readings

I like pre-bed blood sugar readings because they reveal the cumulative effects of your daily meals on your blood sugar. Blood sugar is affected by many factors, including how well your body can dispose of blood sugar from meals consumed earlier in the day (and earlier in the week). If your pre-bed blood sugar readings are consistently higher than those taken earlier in the day, metabolic mayhem is likely developing.

If you go to bed more than three hours after your last meal, check your blood sugar before your head hits the pillow. If you wrap up the day less than three hours before going to bed, your final postprandial blood sugar reading will be your pre-bed reading. If you go to bed 2 hours after dinner, your pre-bed blood sugar reading will replace your 2-hour postprandial blood sugar reading.

Pre-Bed Blood Sugar Reference Ranges for *Glucose-Adapted* Subjects:

- Healthy—below 85 mg/dl
- Insulin resistant—86 to 99 mg/dl
- Prediabetic—100 to 125 mg/dl
- Diabetic—126 mg/dl or above

Note: the pre-bed reference ranges are for blood sugar readings taken three or more hours after your last meal of the day. If your last meal was consumed less than three hours before bed, compare your pre-bed blood sugar readings to the postprandial blood sugar reference ranges and not the pre-bed reference ranges.

Interpreting Glucose-Adapted Blood Sugar Readings

If your glucose-adapted blood sugar readings are all within healthy limits, you'll likely be able to burn fats and ketones simply by eliminating carbs from your diet. If some of your glucose-adapted readings indicate the presence of insulin resistance or prediabetes, you may still be able to switch to a fat-based diet by eliminating carbs. But suppose several of your readings indicate the presence of insulin resistance or prediabetes. In that case, *steps will likely have to be taken to heal your metabolism before metabolizing fats and ketones is possible*. If your glucose-adapted blood sugar readings indicate the presence of type 2 diabetes, it's absolutely positively necessary to heal your metabolism before

switching to a fat-based diet. These crucial points are explored in detail in the coming chapters of the Metabolism Section.

Table 10: Glucose-Adapted Blood Sugar Reference Ranges

	Healthy	Insulin Resistant	Prediabetes	Diabetes
Waking	Below 85	86-99	100-125	126 or above
Postprandial 1-hour	Below 140	Above 140	Above 140	Above 140
Postprandial 2-hour	Below 120	Above 120	Above 125	Above 140
Postprandial 3-hour	Below 85	86-99	100-125	126 or above
Pre-meal	Below 85	86-99	100-125	126 or above
Pre-bed	Below 85	86-99	100-125	126 or above

Summarizing Glucose-Adapted Blood Sugar Readings

- If your glucose-adapted blood sugar readings indicate advancing or advanced metabolic mayhem, it's necessary to heal your metabolism before switching to a fat-based diet. If you don't, it's guaranteed that you won't be able to burn fat, even if you cut out carbs.
- Government and medical glucose-adapted blood sugar reference ranges are notoriously broad and cannot be relied on.
- It's necessary to check your blood sugar upon waking, 1, 2 and 3 hours after meals, immediately before lunch and dinner, and before bed.
- Waking/fasting glucose-adapted blood sugar readings can indicate the presence of insulin resistance, prediabetes or type 2 diabetes.
- If postprandial, between meal or pre-bed readings are elevated, insulin resistance, prediabetes or type 2 diabetes is suspected.

Fat-Adapted Blood Sugar Reference Ranges

The Crystal Ball Effect of Fat-Adapted Blood Sugar Readings

When your metabolism heals and your cells become increasingly adapted to making ATP from fats and ketones, your blood sugar will exist within a very narrow (and very healthy) range around the clock. This makes it possible to notice the effects that overeating, skipping a meal, not getting enough sleep, exercise, fiber intake, stress, travel, caffeine and even meditation have on your fat-adapted blood sugar. Once you're deeply fat-adapted, your blood sugar readings become like a crystal ball that you can peer into and see how your recent choices are affecting your health in the present moment.

Waking Blood Sugar Readings Are Completely Different When You're Fat Adapted

As you wake up for the day and your feet are about to hit the floor, cortisol levels increase markedly, which raises blood sugar. This bumping up of waking blood sugar is known as the *dawn phenomenon*, and was first described in the scientific literature in 1984[333]. The dawn phenomenon, which kicks gluconeogenesis into gear, *happens whether you're fat-adapted or glucose adapted*. In non-diabetic glucose-adapted subjects, insulin levels also rise markedly as part of the dawn phenomenon, which slows down the liver's gluconeogenic output and keeps blood sugar levels in check.

But as you become fat-adapted, insulin sensitivity is optimized, and your body becomes highly sensitive to minimal insulin secretions. In a state of ideal insulin sensitivity, the liver can fine-tune the dawn phenomenon *independent of the need for insulin*. Stated differently, when you become deeply fat-adapted, your liver doesn't have to produce nearly as much blood sugar when you wake up, and insulin doesn't have to be secreted from the pancreas to regulate how much blood sugar the liver produces. When you're glucose adapted and your blood sugar is yo-yo-ing up and down all day, a sizable release of insulin is required to control the dawn phenomenon. Yet, when you're fat-adapted, the liver can fine-tune the amount of blood sugar it produces upon waking, and it can do so with little or no guidance from insulin.

Can You Repeat That?

Let's briefly recap this vital point: cortisol levels increase upon waking, which cues the liver to increase its production of blood sugar. This is known as the dawn phenomenon, which occurs whether you're glucose- or fat-adapted. As your metabolism heals and your insulin sensitivity becomes optimized, very little and perhaps no insulin is required to regulate the amount of blood sugar your liver produces upon waking—providing that you're fat-adapted.

The dawn phenomenon often goes unnoticed in the blood sugar readings of non-diabetic glucose-adapted subjects (people who are following a carbohydrate-based diet and can produce ample amounts of insulin), because insulin puts the brakes on the liver's production of waking blood sugar. But when fat becomes your primary fuel, your liver can fine-tune the amount of waking blood sugar it produces to such an extent that it does so with very little or no help from insulin.

Waking Fat-Adapted Blood Sugar Readings Tend to *Increase* When Metabolism Heals

For these reasons, fat-adapted waking blood sugar readings differ from glucose-adapted waking readings. It can initially send chills up your spine, but when your metabolism is healed, your waking blood sugar readings will likely go up, not down, when you're making ATP from fats and ketones. Indeed, fat-adapted waking blood sugar readings are commonly between 90-115 mg/dl. This isn't a problem, and if your waking readings are higher than your glucose-adapted readings, it's almost always a clear sign that you're burning fat. *Elevated fat-adapted waking blood sugar readings are not signs of pathology; they're signs of optimal insulin sensitivity*.

If your body produces robust amounts of cortisol as you wake, your fat-adapted waking blood sugar may be as high as 115 to 120 mg/dl, perhaps even as high as 125 mg/dl. This is especially likely if your pancreas secretes very little or even no insulin to counteract the liver's production of waking blood sugar. On the other hand, if your cortisol levels don't rise as high in the morning, or if your pancreas secretes a bit of insulin to put the brakes on the dawn phenomenon, your waking blood sugar readings are likely to be closer to 90 mg/dl. We'll continue to deepen our awareness of this noteworthy point throughout the rest of this section. And as we'll see, even if your waking blood sugar readings go up, your hemoglobin A1c readings will drop significantly, providing clear evidence that your overall blood sugar levels are as healthy as healthy can be.

The Ketogenic Diet Doesn't Cause Insulin Resistance, it Heals it

A somewhat common misperception is that becoming deeply fat-adapted—which optimizes how sensitive your liver, tissues and cells are to the effects of insulin—is to become insulin resistant. There are two main reasons for this misperception. The first is that ketoadapted subjects commonly exhibit a pronounced dawn phenomenon—which is also common in diabetics because they don't produce insulin. However, insulin-resistant, prediabetic and diabetic subjects will consistently have elevated A1c results, whereas ketoadapted subjects whose metabolism is healed will have healthy A1c readings, *regardless of waking blood sugar readings*.

The second reason for this misperception is that ketoadapted subjects typically fail a *glucose tolerance test*, a procedure used to diagnose diabetes. The glucose tolerance test involves ingesting a whopping 75 grams of glucose and determining how long it takes for blood sugar to return to normal levels. When you're deeply ketoadapted, your pancreas won't release much insulin, even if you flood your system with 75 grams of sugary glucose syrup. Seventy-five grams of glucose syrup is the equivalent of 15 teaspoons of sugar, and will result in a 17-fold increase in blood sugar levels.

The fact that I and everyone else who's deeply ketoadapted would miserably fail a glucose tolerance test (and feel miserable as well) causes keto naysayers to assert that the keto diet leads to insulin resistance, but this isn't true in the slightest. Furthermore, this assertion is easily proven false because if ketoadapted subjects consume carbohydrates regularly, thus switching to a glucose-based metabolism, passing a glucose tolerance test ceases to be an issue. Regardless, I don't advocate that anyone undergo a glucose tolerance test to determine if diabetes has developed. There are far more elegant and less dangerous means of diagnosing blood sugar issues.

Elevated Fat-Adapted Waking Blood Sugar Readings and the A1c Test

As your metabolism heals and you become fat-adapted, you'll have less sugar in your blood at all times, even if your fat-adapted waking readings are higher than your glucose-adapted waking readings. The easiest way to prove this is with the hemoglobin A1c test. Recall that the hemoglobin A1c test measures the average amount of sugar in your blood over 120 days. As you become increasingly fat-adapted, your A1c readings are likely to drop below 5.0, which is practically unheard of for glucose-adapted subjects. Thus if your A1c readings gradually drop, it's a sure sign that there's less sugar in your blood, even if your waking readings increase as you become fat-adapted. Conversely, if your A1c readings don't gradually drop when you cut out carbs, it's a sign that dietary changes are necessary or that your metabolism requires further healing.

The curious phenomenon of divergent fat-adapted blood sugar and A1c readings was alluded to in the previous chapter. When your body becomes increasingly fat-adapted, the interplay of insulin and the Big Five Hormones changes dramatically. As this happens, your fat-adapted blood sugar readings will have different meanings and must be interpreted differently, because they don't mean the same as your glucose-adapted readings.

The Effects of Metabolic Mayhem on Waking Blood Sugar Readings

If your metabolism is healthy and healed, your waking blood sugar readings will likely increase when you switch to a fat-based diet. This is so predictable that when fat-adapted waking readings *don't* rise, it's practically a given that metabolic mayhem persists. If you're still dealing with metabolic mayhem when you switch to a fat-centered diet, your waking blood sugar readings may *decrease* rather than increase. If you're prediabetic and your glucose-adapted waking blood sugar readings average 120 mg/dl, your fat-adapted waking readings may drop below 95 mg/dl. When glucose-adapted blood sugar readings are high *and* all the signs indicate that metabolism is damaged, fat-adapted blood sugar readings almost always decrease when switching to a fat-based diet.

Type 2 Diabetes Often Produces Chaotic Blood Sugar Readings

As type 2 diabetes develops and progressively worsens, blood sugar readings can become chaotic to the point of unreliability. For example, in the presence of type 2 diabetes, consuming foods that contain no carbohydrates or sugars, e.g., a cup of coffee with two tablespoons of heavy cream or a salad and an egg, can cause blood sugar to zoom into the 300-400 mg/dl range, sometimes higher. Blood sugar readings such as these indicate advanced diabetes, which must be healed before switching to a fat-based diet.

Note: people with diabetes can heal their metabolism and safely switch to a fat-based diet. This must be assessed on a case-by-case basis.

Waking and *Fasting* Refer to Different Things When You're Fat Adapted

It's necessary to distinguish between fat-adapted *waking* blood sugar and fat-adapted *fasting* blood sugar. *Fasting* blood sugar is the amount of glucose in your blood in a fasting state, i.e., when you've not eaten for more than 8 hours. *Waking* blood sugar is the blood sugar in your body for the first few minutes after your feet hit the floor and you get out of bed. When you're fat-adapted, your waking blood sugar readings won't be the same as fasting blood sugar readings. For example, if your waking blood sugar is 110 mg/dl, it may drop to 85 mg/dl once you've been out of bed for 30 minutes. This is due to the dawn phenomenon.

Waking Blood Sugar Reference Ranges for Fat-Adapted Subjects:

In general terms, fat-adapted waking blood sugar readings tend to increase when metabolism is healed, and decrease when metabolism is still healing. By and large, fat-adapted waking blood sugar readings for fat-adapted subjects are between 90-115 mg/dl, though they may eclipse 120 mg/dl.

- Healthy—between 90-115 mg/dl

Regardless of your waking blood sugar readings, you must cross-reference your waking readings with other metabolic biomarkers and compare them to your glucose-adapted blood sugar readings. For example, if your glucose-adapted waking blood sugar readings average 86 mg/dl and your fat-adapted readings average 84 mg/dl, it's difficult to say if you've become fat-adapted by assessing your blood sugar. In that case, biomarkers such as triglycerides, A1c, HDL

cholesterol, the triglyceride/HDL ratio, fasting insulin and body fat stores must be assessed to determine if your metabolism is healing and you're burning fats and ketones.

If your glucose-adapted readings average 115 mg/dl and your fat-adapted readings average 110 mg/dl, it's difficult to know if your metabolism is healing and you're burning fats and ketones, or if metabolic mayhem persists. As in the previous example, it's necessary to assess triglycerides, A1c, HDL cholesterol, the triglyceride/HDL ratio, fasting insulin and body fat stores to determine if blood sugar readings indicate that fat is being metabolized, or if metabolic mayhem persists.

Post-Meal Blood Sugar Readings Stabilize When Burning Fats and Ketones

Carbohydrates and sugar have potent effects on postprandial blood sugar and insulin levels; these effects are substantially greater than those produced by fat and protein[334,335]. Suppose your metabolism is healed and you consume low-carbohydrate meals that don't include excess protein (this is explored later in the Metabolism Section). In that case, your fat-adapted postprandial blood sugar readings will be uniformly lower than your glucose-adapted postprandial readings. Not only will your postprandial readings be lower, but they will also return to healthy fasting levels far more quickly than glucose-adapted readings. This is a crucial point, because glucose-adapted postprandial blood sugar readings often don't return to healthy fasting levels for several hours—sometimes not until the next day. In contrast, healthy fat-adapted postprandial blood sugar levels are achieved in less than 2 hours.

A question you may be asking yourself at this point is, "Why does my blood sugar increase after meals if I don't eat carbs?" Blood sugar is a peculiar metabolic biomarker. Even though the meals you consume when you're fat-adapted won't contain sugar or carbs, your liver creates a little blood sugar when you eat. It comes as a surprise, but if your postprandial blood sugar doesn't slightly increase when you're fat-adapted, it can be a sign that unhealed metabolism is causing excess insulin secretions that are driving blood sugar levels down.

Fat-adapted waking blood sugar readings can appear high due to the negligible amount of insulin secreted to counteract the natural rise in waking blood sugar; postprandial readings can seem high for the same reason. Recall that there are two types of insulin secretions: basal and bolus. Basal insulin is akin to a drip system that continually secretes minimal amounts of insulin into the blood, and bolus is a more significant release of insulin that occurs in response to the meals you consume. When your metabolism is healed and you're fat-adapted, the amount of bolus insulin secreted following meals can be surprisingly small. As a result, blood sugar readings taken following meals may appear falsely elevated. Even so, your fat-adapted postprandial blood sugar readings will be considerably lower than your glucose-adapted postprandial readings. And as already mentioned, postprandial fat-adapted blood sugar readings will return to healthy levels far more quickly than glucose-adapted blood sugar readings.

Postprandial Blood Sugar Reference Ranges for Fat-Adapted Subjects:

- 1-hour: below 120 mg/dl
- 90 minutes: below 115 mg/dl
- 2-hour: below 100 mg/dl

If your fat-adapted postprandial blood sugar readings are above this range, it's likely that your metabolism requires further healing, or that you're consuming too much protein (or both). Protein consumption is explored later in the Metabolism Section. If your fat-adapted postprandial readings are below these reference ranges, there's no need for concern. However, if they're above these ranges, cross-reference them with other metabolic biomarkers to ensure your metabolism is healing and heading toward optimization.

Low Insulin Production: Why Fat-Adapted Fasting (and Waking) Blood Sugar May *Appear* Higher

As you become fat-adapted, your *fasting* blood sugar readings may be higher than your glucose-adapted fasting readings. By now, the reason for this curious phenomenon can be understood: *minuscule insulin secretions*. When you're fat-adapted, your pancreas secretes very little insulin, which can cause your blood sugar readings to appear falsely elevated, including fasting blood sugar readings. When I first switched to a fat-based diet, I freaked out over the fact that my waking readings averaged about 110 mg/dl, and I was sure that something was gravely wrong. However, my fears that something had gone seriously wrong were eased when my fasting blood sugar readings

(readings taken more than 30 minutes after waking and more than two hours after meals) hovered around 92 mg/dl. It wasn't until I realized that my A1c readings were below 5 that I could fully trust that my fat-adapted blood sugar readings were healthier than ever before and had to be interpreted differently than my glucose-adapted readings.

Pre-Meal Blood Sugar Readings

For the most part, your pre-meal blood sugar readings will be the same as your fasting ones once you're fat-adapted. This is because pre-meal blood sugar readings are taken immediately before lunch and dinner. If pre-meal blood sugar readings remain elevated, it's likely that metabolic mayhem persists, or that excess protein is being consumed (or both).

Pre-Meal Blood Sugar Reference Ranges for Fat-Adapted Subjects:

- 2-hours since your last meal: below 100 mg/dl
- 3-hours since your last meal: below 95 mg/dl

Pre-Bed Fat-Adapted Blood Sugar Readings

In the same way that glucose-adapted pre-bed blood sugar readings provide helpful insight into your metabolism, fat-adapted pre-bed readings also provide excellent insight into your metabolism. Suppose your pre-bed fat-adapted blood sugar readings are consistently elevated. In that case, it's a good sign that your metabolism requires further healing, or that excess protein is being consumed (or both). Consuming excess fat can also increase pre-bed (and other) blood sugar readings. As with all fat-adapted blood sugar readings, it's important to cross-reference your pre-bed readings with other metabolic biomarkers if they're consistently elevated.

Pre-Bed Blood Sugar Reference Ranges for Fat-Adapted Subjects:

- Healthy—below 95 mg/dl (as measured 2 or more hours after your last meal of the day)

Interpreting Fat-Adapted Blood Sugar Readings

Healthy fat-adapted blood sugar readings vary more widely from person to person than healthy glucose-adapted readings. When it comes to healthy fat-adapted blood sugar readings, what's normal for one person isn't necessarily what's normal for another. This makes it difficult to shoehorn the blood sugar readings for all fat-adapted subjects into a single healthy reference range. This is particularly true of waking blood sugar readings. Unlike waking readings, your fat-adapted postprandial, pre-meal and pre-bed readings won't stray too far from the healthy range when your metabolism is healed and your dietary choices become finely tuned.

Suppose your waking readings are consistently above or below healthy limits but the rest are within healthy limits. In that case, measuring other metabolic biomarkers is necessary to interpret your waking readings correctly. For example, if your waking fat-adapted blood sugar readings are consistently above 120 mg/dl and the rest of your blood sugar readings are within healthy limits *and* your A1c drops below 5, *and* the majority of your metabolic biomarkers are within optimal limits, there's no reason to be concerned about your waking readings. But if your blood sugar, A1c and other metabolic biomarkers indicate the presence of metabolic mayhem, it's likely that it persists and needs to be addressed.

In general, if your *glucose-adapted* readings are mostly within healthy reference ranges, it's likely that your fat-adapted readings will also be within healthy reference ranges. But if your glucose-adapted readings indicate the presence of prediabetes or type 2 diabetes, your fat-adapted readings will likely be higher than the fat-adapted reference range. If your fat-adapted readings are consistently above the healthy range, you must heal your metabolism before switching to a fat-centered diet.

Table 11: Fat-Adapted Blood Sugar Reference Ranges

Time Of Measure	Healthy
Waking	Between 90-115
Postprandial 1-hour	Below 120
Postprandial 90 min	Below 115
Postprandial 2-hour	Below 100

Time Of Measure	Healthy
Pre-meal 3-hours	Below 95
Pre-bed	Below 95

Metabolism Recap #7: Fat-Adapted Blood Sugar Readings

- As your metabolism heals and you become fat-adapted, your blood sugar readings will take on unique characteristics.
- These characteristics are solid indicators that you're burning fats and ketones.
- Fat-adapted blood sugar readings are not the same as glucose-adapted blood sugar readings, and must be interpreted with different reference ranges.
- Fat-adapted waking blood sugar readings are higher than glucose-adapted readings once metabolism is healed.
- Healthy fat-adapted metabolism allows for the "crystal ball" effect, in which you can determine how subtle dietary changes, stress, lack of sleep, etc., impact your blood sugar readings.
- Healthy fat-adapted waking blood sugar readings tend to be higher than healthy glucose-adapted blood sugar readings.
- This is what's known as the dawn phenomenon.
- The dawn phenomenon results from increased insulin sensitivity, not decreased insulin sensitivity.
- *Actual* blood sugar is lower when fat-adapted, which is corroborated by the hemoglobin A1c test.
- Fat-adapted postprandial blood sugar readings don't rise as high as glucose-adapted postprandial blood sugar readings.
- Fat-adapted postprandial blood sugar readings return to healthy fasting levels more quickly than glucose-adapted postprandial readings.
- Fat-adapted between-meal blood sugar readings return to healthy fasting levels within 2 hours following meals.
- Fat-adapted between-meal blood sugar readings are generally the same as fat-adapted fasting blood sugar readings.

Can Measuring Ketones Tell Me if I'm Burning Fats and Ketones?

Contrary to popular opinion, measuring ketones, whether in the blood or the urine, isn't reliable for determining if you're burning fats and ketones. Even though it seems counterintuitive, measuring your blood sugar is more accurate for determining if you're burning fats and ketones than measuring ketones. The following bullet points summarize the many reasons why this is so.

Why Ketones Are Unreliable Indicators of Metabolic Mayhem and Nutritional Ketosis:

- Ketone production rates vary between 115-180 grams per day, influencing blood and urinary ketone levels[336,337,338,339].
- Ketone levels naturally vary throughout the day (levels are lowest in the morning and highest around midnight)[340].
- Ketone levels vary depending on how long you've been in nutritional ketosis[341,342,343].
- Women produce more ketones than men, and children produce more ketones than adults[344,345,346].
- Ketone levels vary after meals, between meals and when fasting[347].
- Urinary excretion rates of ketones vary too widely to be relied on as an indicator of nutritional ketosis[348].
- Normal variations in hormone levels affect urinary ketone excretion rates[349].
- Common supplements, including vitamin C[350] and N-acetyl-cysteine[351], can falsely elevate ketone levels.
- Dehydration can falsely elevate ketone levels[352].
- Being fully hydrated or over-hydrated can falsely lower ketone levels[353].

A lot remains to be known about ketones. What's clear at this point is that blood and urinary ketone levels vary widely throughout the day. This is based on age, gender, length of time in ketosis, and other factors. Whereas blood sugar levels are predictable throughout the day, ketone levels exhibit considerable variability and cannot be used to assess nutritional ketosis.

What to Do If Your Blood Sugar Readings Don't Make Sense

It's not uncommon for some of your blood sugar readings to vary from the above guidelines. Human physiology is incredibly complex, and there are exceptions to every rule. If you're putting forth the diligent effort to heal your metabolism and some of your readings fall outside those described, don't be too concerned. Keep in mind that blood sugar and other lab values differ slightly from person to person. Relying on blood sugar isn't an exact science, but doing so nonetheless provides helpful insight into your metabolism.

- Rely on A1c
- Rely on all of your metabolic biomarkers, e.g., A1c, cholesterol, triglycerides

Metabolism Recap #8: Blood Sugar Readings

- Some biomarkers, e.g., A1c, require different reference ranges for glucose-adapted and fat-adapted populations.
- If your glucose-adapted blood sugar readings indicate the presence of metabolic mayhem, it's necessary to heal your metabolism before switching to a fat-based diet. If you don't, it's guaranteed that you won't be able to burn fat, even if you cut out carbs.
- Glucose-adapted blood sugar reference ranges are notoriously broad and cannot be relied on.
- It's necessary to check your blood sugar upon waking, 1, 2 and 3 hours after meals, immediately before lunch and dinner, and before bed.
- Waking/fasting glucose-adapted blood sugar readings can indicate the presence of insulin resistance, prediabetes or type 2 diabetes.
- If postprandial, between meal or pre-bed readings are elevated, insulin resistance, prediabetes or type 2 diabetes is suspected.
- As your metabolism heals and you increasingly become fat-adapted, most metabolic biomarkers will naturally and spontaneously become optimized.
- When your metabolic biomarkers become optimized, you'll have proof that the dietary changes you're making minimize your risk of developing chronic diseases and maximize your potential longevity.
- If you want to know what's going on with your metabolism, check your blood sugar.
- The emergence of specific blood sugar patterns is the best way to determine if you're burning fats and ketones.
- Blood sugar readings provide "up-to-the-minute status reports" about the workings of your metabolism.
- Monitoring your blood sugar can motivate you to implement much-needed life changes.
- It's crucial to begin monitoring your blood sugar before changing your diet.
- You can determine if you're becoming fat-adapted by comparing your glucose-adapted readings to your fat-adapted readings.
- Glucose-adapted blood sugar readings are not the same as fat-adapted readings.
- Due to greatly diminished insulin levels and greatly enhanced insulin sensitivity, fat-adapted blood sugar readings (excluding postprandial readings) may be higher than glucose-adapted readings.
- Elevated waking fat-adapted readings are known as the dawn phenomenon.
- When your metabolism heals and you're burning fats and ketones, your A1c readings are likely to drop below 5, which is hard evidence that your overall blood sugar is very low and very healthy.
- Glucose-adapted A1c readings below 5 are the stuff of dreams, but are common when fat-adapted.
- Once you're deeply fat-adapted, your blood sugar readings become like a crystal ball that you can peer into and see how your recent choices are affecting your health in the present moment.
- If your glucose-adapted blood sugar readings are high, indicating insulin resistance, prediabetes or type 2 diabetes, your fat-adapted blood sugar readings will reduce when your metabolism heals. If they don't, advanced metabolic mayhem is likely interfering with fat burning.
- If your glucose-adapted blood sugar readings are healthy, your fat-adapted readings will likely increase.
- Fat-adapted blood sugar readings must be cross-referenced with as many metabolic biomarkers as possible.
- Type 2 diabetes can cause blood sugar readings to become so chaotic that they can't be used to assess metabolism.
- Waking and fasting blood sugar readings are different when you're fat-adapted. *Fasting* blood sugar is the amount of glucose in your blood in a fasting state, i.e., when you've not eaten for more than 8 hours. *Waking* blood sugar is the blood sugar in your body for the first few minutes after your feet hit the floor and you get out of bed.

- Even though you won't consume carbs when you're fat-adapted, your post-meal blood sugar readings will increase. This is normal, even when you're fat-adapted. A hallmark of healthy fat-adapted metabolism is that postprandial blood sugar readings won't rise nearly as much as glucose-adapted postprandial readings. They will return to healthy fasting levels sooner, typically within 2 hours.
- Glucose-adapted between-meal blood sugar readings will remain elevated in the presence of metabolic mayhem, but will drop to healthy fasting levels when you're fat-adapted.
- Ketones are unreliable for determining if you're burning fats and ketones.
- Blood sugar readings will guide you through the process of switching to the Metabolic Masterplan Diet.

What's Next?

Now that we've reviewed metabolism, biomarkers and blood sugar in detail, the moment you've been waiting for has finally arrived: how to switch to the Metabolic Masterplan Diet (MMD)! The next chapter, Healing and Optimizing Your Metabolism, provides step-by-step instructions on safely switching to the MMD.

Chapter 12:
Implementing the Metabolic Masterplan Diet

Well done! You've learned so much about metabolism that you're well on your way to earning an honorary Ph.D. in the subject. The reason you've taken the time to become so well-versed about ATP, RONS, mitohormesis, gluconeogenesis, basal and bolus insulin, counterregulatory hormones, glycogen, de novo lipogenesis, adiponectin, brown adipose tissue, metabolic biomarkers, blood sugar patterns and more is to be able to heal and optimize your metabolism. You've learned a tremendous amount about metabolism, and you're now ready to take the exciting step of applying everything you've learned and switching to the Metabolic Masterplan Diet.

Take Your Time, Don't Rush the Transition to the Metabolic Masterplan Diet

Healthy Past 100 isn't just another book cashing in on the ketogenic diet craze. (If it were, it wouldn't have taken nearly eight years to complete.) Whereas most keto books don't even mention the all-too-common challenges encountered when switching to a ketogenic diet, *HP100* addresses these issues in fine detail to ensure you do it right the first time. We're nearing the end of the Metabolism Section, and after all the material we've covered, you may be tempted to jump ahead. *Don't*. Take your time and read this last chapter of the Metabolism Section carefully.

Perform a Self-Assessment of the Common Indicators of Metabolic Mayhem

In addition to measuring metabolic biomarkers and monitoring your blood sugar, another practical means of determining if you've developed metabolic mayhem is taking the metabolic mayhem personal assessment test. To do so, review the items in Table 12 and count how many apply to you. If fewer than six apply, you're likely not dealing with metabolic mayhem. On the other hand, if 7-8 indicators apply, metabolic mayhem may be developing. If nine or more indicators apply, chances are good that you'll need to heal metabolic mayhem to metabolize fats and ketones efficiently.

Table 12: The Common Indicators of Metabolic Mayhem

You're overweight or obese	You can't easily lose weight
You've followed a Western diet for years	You've been overweight or obese for many years
You have VAT, even if you're otherwise thin	You have sarcobesity (muscle wasting with obesity)
You regularly consume (or once consumed) sugar	You have a history of overeating
You experience sugar or carb cravings	You sometimes experience hunger after eating a large meal
You have a history of being sedentary	You have a history of being stressed out
You don't get regular, prolonged cardio exercise	You don't regularly perform strength-training exercises
You have a history of high blood pressure	You consume(d) alcohol (even in moderation)
You're hypothyroid (see the Thyroid Section)	You have a history of smoking (past or present)
You have gut issues (see the Healing the Gut Section)	You've been diagnosed with metabolic syndrome
You're insulin resistant, prediabetic or diabetic	You've been diagnosed with non-alcoholic fatty liver disease
You have high blood sugar	Your metabolic biomarkers fall outside of healthy ranges

How Many Items From Table 12 Apply to You?

- 6 or less: low chance that metabolic mayhem has developed
- 7-8: moderate chance that metabolic mayhem has developed
- 9 or more: good chance that metabolic mayhem has developed

Nearly everyone can identify at least six indicators from Table 12 that apply to them, and most people identify seven or eight. If nine or more of these indicators apply to you, chances are good that you've developed metabolic mayhem to such an extent that it will interfere with your ability to create ATP from fats and ketones. When the metabolic mayhem personal assessment test results are combined with your metabolic biomarkers and blood sugar readings, you'll know which step of the Metabolic Masterplan Diet is your appropriate starting point.

Measure Metabolic Biomarkers and Blood Sugar

The crucial importance of measuring metabolic biomarkers and blood sugar was reviewed in detail in the previous two chapters. If you haven't already done so, have your metabolic biomarkers tested and begin checking your blood sugar *before* switching to the Metabolic Masterplan Diet (MMD). The information provided by metabolic biomarkers and blood sugar readings is needed to guide you through the process of switching to the MMD.

The Metabolic Masterplan Diet Is Implemented in 5 Steps

Metabolism is complex, and we've seen throughout the Metabolism Section that much can go wrong with our metabolism when we rely on a carbohydrate-centered Western diet for any length of time. Given the complexities of metabolism and the ease with which metabolic mayhem develops, the process of healing your metabolism and switching to the Metabolic Masterplan Diet (MMD) has been carefully laid out in five distinct steps to make transitioning to the MMD as smooth as possible.

Table 13: The 5 Steps of Switching to the Metabolic Masterplan Diet

Step	What Each Step Involves
Step 1	Determine if you've developed metabolic mayhem by measuring metabolic biomarkers, monitoring your blood sugar, and performing the self-assessment of the common indicators of metabolic mayhem. If metabolic mayhem has developed, go to Step 2 and heal your metabolism. If metabolic mayhem has not developed, go to Step 4.
Step 2	Strictly limit carbohydrates, eliminate sugars and alcohol, limit fat intake, consume moderate protein and get plenty of exercise until your metabolism is healed. Then remain at Step 2 until your metabolism is healed and your cells can create ATP from fats and ketones. Do not skip this step!
Step 3	Determine if the actions you're taking in Step 2 are healing metabolic mayhem by re-testing metabolic biomarkers and monitoring blood sugar. Then, when metabolic mayhem heals, go to Step 4.
Step 4	Implement the Metabolic Masterplan Diet by strictly limiting your intake of carbohydrates, eliminating sugar and alcohol, consuming moderate protein, and consuming the fat your cells require to create ATP. Get plenty of regular exercise. Monitor metabolic biomarkers and blood sugar to naturally move towards Step 5.
Step 5	Continue to make lifestyle interventions until your metabolism becomes optimized and you experience the benefits of miraculous metabolism. Then make small lifestyle interventions as needed to maintain miraculous metabolism.

Step 1: Determine if You've Developed Metabolic Mayhem

The good news is that Step 1, which is to *determine if you've developed metabolic mayhem*, has already been thoroughly reviewed. Step 1 of the Metabolic Masterplan Diet is accomplished by measuring metabolic biomarkers, monitoring your blood sugar, and performing the self-assessment of the common indicators of metabolic mayhem. Step 1 is so important that the previous two chapters (Metabolic Biomarkers and Blood Sugar Readings) were written so that you'll be able to determine the extent to which metabolic mayhem has developed. Without the information that Step 1 provides, you're playing guessing games with your health, which is never a good idea.

Test Metabolic Biomarkers and Blood Sugar, Then Advance to Step 2 or Step 4

If your metabolic biomarkers, blood sugar readings and the metabolic mayhem personal assessment test indicate the presence of metabolic mayhem, go to Step 2 and take the actions necessary to heal your metabolism. If metabolic mayhem hasn't developed, go to Step 4.

Step 2: Healing Metabolic Mayhem

When I was a keto greenhorn in 2015, I assumed everyone could switch to a fat-based diet by cutting carbs and saying *sayonara* to sugar. I learned right from the start that this often isn't the case, and many years later, I'm still

learning about how metabolic mayhem destroys our health and interferes with our ability to create ATP from fats and ketones. If you need to heal your metabolism, Step 2 was written to help you do just that.

My clinical experience has taught me well that to heal metabolic mayhem—especially advanced metabolic mayhem—it's necessary to strictly limit carbohydrates, eliminate sugar and alcohol, stick to moderate protein consumption, *and* restrict your fat intake. Restricting fat intake seems counterintuitive to switching to a fat-based diet. But when metabolic mayhem crosses a certain threshold, consuming too much fat will send gluconeogenesis into overdrive and chronically refill your glycogen stores, bringing fat burning to a grinding halt. Additionally, getting as much exercise as possible is crucial to deplete glycogen stores if you're dealing with metabolic mayhem. You'll continually deplete glycogen stores by being on your feet, taking as many steps as possible and staying as active as possible. Please refer to the Exercise Section for more information on getting regular exercise and depleting glycogen stores.

Step 2 of the MMD Is Not the Same as Fasting

To heal metabolic mayhem, Step 2 of the Metabolic Masterplan Diet strictly limits carbohydrates, eliminates sugar and alcohol, restricts fat intake, and ensures you don't overdo it with protein. Step 2 includes consuming a variety of non-starchy vegetables, e.g., greens and cauliflower, supplementary fibers (psyllium and acacia), and minerals such as potassium and magnesium.

Step 2 of the Metabolic Masterplan Diet *is different from fasting*. Fasting is the complete cessation of all foods except fluids such as water and tea. There's a time and place for prolonged fasting, but healing advanced metabolic mayhem requires that calories be restricted for longer than nightly, intermittent, and even most prolonged fasts can accomplish.

It's possible to vastly improve and even heal advanced metabolic mayhem through prolonged fasting. Regardless, in my experience, two and even three weeks fasts are usually far too short to heal advanced metabolic mayhem. And while a series of 2-week fasts or a 5-6 week fast (or longer) may heal advanced metabolic mayhem, the arduous nature of such undertakings is brutally difficult for most, not to mention dangerous and potentially damaging to your health when not done exactly right. Once metabolic mayhem becomes advanced, no amount of intermittent fasting will turn it around.

This is why I don't recommend prolonged or intermittent fasting to heal metabolic mayhem. Instead, I specifically developed Step 2 of the Metabolic Masterplan Diet to heal even the most advanced states of metabolic mayhem. Unlike fasting, Step 2 of the Metabolic Masterplan Diet includes the nutrients required to sustain your body and keep you healthy while you're healing your metabolism. Recipes in the Metabolic Masterplan Cookbook that it's safe to consume at Step 2 include "All Steps" in the title.

To Help You Safely Heal Your Metabolism, Step 2 of the Metabolic Masterplan Includes the Following Components:

- Restrict carbohydrates and eliminate sugar and alcohol
- Limit fat intake to a bare minimum, e.g., a splash of cream in your coffee
- Consume enough protein to meet your daily requirements—explained in the Core Essentials Section
- Consume a variety of nonstarchy vegetables (see the Metabolic Masterplan Cookbook)
- Supplement with psyllium and acacia to feed your gut and provide a feeling of satiety—see the Core Essentials Section
- Drink an abundance of fluids
- Consume an abundance of minerals, e.g., potassium and magnesium
- Get plenty of exercise every day. Moving your body is a crucial step in healing metabolic mayhem
- Destress
- Only consume recipes from the Metabolic Masterplan Cookbook that contain "Step 2" in the title

The Rubber Band Effect: Metabolic Mayhem Replenishes Glycogen Stores

An important point introduced earlier in this section is that when metabolic mayhem becomes advanced, consuming foods—even foods that don't increase blood sugar when metabolism is healthy—can cause the liver to significantly increase gluconeogenic output. When gluconeogenesis spins out of control, glycogen stores are perpetually

replenished, and it becomes physiologically impossible for your cells to create ATP from any metabolic fuel other than blood sugar.

If you experience the rubber band effect of metabolic mayhem, it's necessary to strictly limit carbohydrates, eliminate sugar and alcohol, restrict your intake of fat, consume only as much protein as your cells require daily, and get ample amounts of exercise. This combination of factors will deplete glycogen stores and allow your cells to utilize fats and ketones to create ATP. If your blood sugar readings soar to diabetic levels when consuming non-glycemic foods, you may require insulin injections to manage your blood sugar. This must be assessed on a case-by-case basis.

Approximating How Long You'll Need to Remain at Step 2 of the MMD

To determine how long you must stay at Step 2, figure out which groupings best apply to you.

If There's No Evidence of Metabolic Mayhem, Go Directly to Step 4

- Metabolic biomarkers, including A1c, triglycerides, triglyceride/HDL ratio and insulin are within optimal ranges
- Blood sugar readings are all within optimal ranges
- Six or fewer indicators from the metabolic mayhem self-assessment test
- No history of obesity
- Less than 10 pounds overweight
- No excess visceral adipose tissue (VAT)
- No significant subcutaneous adipose tissue (SAT)
- Current level of health is good to excellent
- No history of major health issues
- You have a history of exercising regularly
- Can quickly lose weight by cutting calories
- No significant life stressors
- You could easily improve health with a little effort, e.g., exercising more, improving diet and destressing
- No significant history of alcohol consumption
- No significant history of sugar consumption
- No history of sarcobesity (muscle wasting with obesity)
- No known history of insulin resistance, prediabetes, type 2 diabetes or metabolic syndrome

Early Stages of Metabolic Mayhem—Remain at Step 2 for 1-3 Days

- Metabolic biomarkers, including A1c, triglycerides, triglyceride/HDL ratio and insulin are near optimal ranges
- Blood sugar readings are near optimal ranges
- Six or seven indicators from the metabolic mayhem self-assessment test
- No history of obesity
- Ten or more pounds overweight
- Carrying a small amount of VAT
- Current level of health is average or better
- Have normal blood sugar throughout the day, especially 60-90 minutes after eating
- You have a history of exercising regularly
- Able to gradually lose weight by reducing caloric intake
- Mild to moderate life stressors
- Could improve health with some effort, e.g., exercising more, improving diet and destressing
- No significant history of alcohol consumption
- No significant history of sugar consumption
- No history of sarcobesity
- No known history of insulin resistance, prediabetes, type 2 diabetes or metabolic syndrome

Moderate Metabolic Mayhem—Remain at Step 2 for 4-5 Days

- Metabolic biomarkers, including A1c, triglycerides, triglyceride/HDL ratio and insulin show signs of moderate metabolic mayhem (see Table 9)
- Some blood sugar readings are above or below optimal ranges
- Seven or eight indicators from the metabolic mayhem self-assessment test

- History of being overweight for 5 or more years (as compared to your optimal weight)
- Currently 15 or more pounds overweight
- Average level of health
- Carrying VAT and SAT that's become harder to shed
- Sometimes unable to exercise due to aches, pains or lack of energy
- Loss of interest in exercise or physical activities
- Beginning to develop health issues
- Moderate life stressors, e.g., financial, health-related or relationship stress
- Experience mild to moderate cravings for carbs and sweets
- Currently consume alcohol or history of alcohol consumption
- History of sugar consumption
- Signs of sarcobesity
- Developing the signs of insulin resistance, prediabetes, type 2 diabetes or metabolic syndrome

Metabolic Mayhem Is Advancing—Remain at Step 2 for 7 Days

- Metabolic biomarkers, including A1c, triglycerides, triglyceride/HDL ratio and insulin are showing signs of moderate and even advanced metabolic mayhem (see Table 9)
- Blood sugar readings are above optimal ranges
- Eight or more indicators from the metabolic mayhem self-assessment test
- History of being overweight for five or more years
- Currently 20 or more pounds overweight
- Fair level of health
- Carrying obvious VAT and SAT that's difficult/impossible to shed
- Blood sugar is high, low or both throughout the day
- Exercise is becoming a challenge/unmotivated to exercise
- Experiencing health issues that are hard to overcome
- History of stress that continues to occur in the present
- Gaining weight is easier than losing it, even with exercise and calorie restriction
- History of alcohol consumption
- Moderate (at least) history of sugar consumption
- Signs of sarcobesity
- Showing the signs of insulin resistance, prediabetes, type 2 diabetes or metabolic syndrome

Advanced Metabolic Mayhem: Remain at Step 2 for 7-14 Days

- Metabolic biomarkers, including A1c, triglycerides, triglyceride/HDL ratio and insulin are showing signs of moderate and even advanced metabolic mayhem (see Table 9)
- Blood sugar readings are above or below optimal ranges
- Eight or more indicators from the metabolic mayhem self-assessment test
- History of being overweight for 10 or more years
- Currently 25 or more pounds overweight
- Carrying significant amount of VAT that's difficult to impossible to shed
- Carrying obvious SAT that's difficult to impossible to shed
- Blood sugar is high, low or both throughout the day
- Fair to poor level of health: unable to do the things you used to do
- Exercise is a challenge or even impossible
- Experiencing health issues that have been difficult to overcome
- History of stress that continues to occur in the present
- All you have to do is look at food to gain weight
- Alcohol consumption *must be stopped* to heal your metabolism
- History of moderate to high sugar consumption
- The signs of sarcobesity are becoming evident
- The signs of insulin resistance, prediabetes, type 2 diabetes or metabolic syndrome are developing

Very Advanced Metabolic Mayhem: Remain at Step 2 For More Than 14 Days

- Metabolic biomarkers, including A1c, triglycerides, triglyceride/HDL ratio and insulin are showing signs of moderate and even advanced metabolic mayhem (see Table 9)
- Blood sugar readings are obviously above or below optimal ranges
- Eight or more indicators from the metabolic mayhem self-assessment test
- History of being overweight for 10 or more years
- Currently 25 or more pounds overweight
- Carrying significant amount of VAT that's very difficult or even impossible to shed
- Carrying obvious SAT that's very difficult or even impossible to shed
- Blood sugar is high, low or both throughout the day
- Fair to poor level of health: unable to do the things you used to do
- Exercise is a challenge or even impossible
- Experiencing health issues that have become difficult to overcome
- History of stress that continues to occur in the present
- All you have to do is look at food to gain weight
- Alcohol consumption *must be stopped* to heal your metabolism
- History of moderate to high sugar consumption
- The signs of sarcobesity are becoming evident
- Clear signs of insulin resistance, prediabetes, type 2 diabetes or metabolic syndrome have developed

When It's Necessary to Remain at Step 2 for More Than 14 Days

Many patients I work with must remain in Step 2 of the Metabolic Masterplan Diet for more than 14 days to heal their metabolism. Some must stay at Step 2 for a year or more to heal metabolic mayhem. Such is the reality of advanced metabolic mayhem. If limiting your food intake for more than two weeks seems like more than you can do, relax and take things one day at a time. The journey of a thousand miles begins with a single step. You can do this, and it's easier than you think. *Far easier*. Even if you've tried every diet there is to try and nothing has worked, the Metabolic Masterplan Diet is different. Have faith in yourself, make the healthiest choices you can make, and you'll soon be surprised by how empowered and healthy you've become.

Attain Your Optimal Weight Before Transitioning to Step 4

Once it becomes difficult for patients to lose weight, they must get close to their optimal weight before their liver can stop overproducing blood sugar. This is why it's often necessary to remain at Step 2 for months, a year, or possibly even longer before moving on to Step 4. Over and over again, I've watched patients struggle to heal their metabolism by switching to Step 4 too soon. When patients ill-advisedly switch to Step 4 before they can efficiently metabolize fat, they experience the frustration of spinning their wheels rather than making progress with their health.

Many have lost touch with what it means to be at their optimal weight. In a world where being overweight has become the new normal, many patients are surprised that their optimal weight is *lower* than they think. When your body is given a chance to exist at its optimal weight—which becomes possible when you follow the Metabolic Masterplan Diet—*it may be lower than what you believe is right for you*. When your body is at its optimal weight, you'll know. You'll feel it. You'll feel and know it because your body will indefinitely stay at or near its optimal weight. This experience can't be understood intellectually, but once you know it experientially, you'll develop a trust in your body's self-regulating capacities that transcends your intellect. This is the beginning of a genuine faith in yourself and your body's inherent recuperative powers.

Summarizing Steps 1-2 of the Metabolic Masterplan

Step 1 Includes:

- Measuring metabolic biomarkers.
- Monitoring your blood sugar.
- Taking the metabolic mayhem personal assessment test.

Step 2 Includes:

- Strictly restricting carbohydrates.
- Eliminating sugar and alcohol.
- Restricting fat intake.
- Consuming only as much protein as your body requires each day.

Step 2 also requires getting as much exercise as possible each day to deplete glycogen stores. If metabolic mayhem has advanced, you may remain at Step 2 for weeks, months, or a year or more. However, the energy you pour into Steps 1 and 2 will return to you 1000-fold in the form of a healthier, happier and more enjoyable life.

Step 3: How to Know if the Metabolic Masterplan Diet Is Working

Step 3 of the Metabolic Masterplan—how to know if the Metabolic Masterplan Diet is working—is a straightforward and vitally important step in healing your metabolism. Fortunately, the main components of Step 3 have already been thoroughly covered: measuring your metabolic biomarkers and monitoring your blood sugar. The steps you took to detect the presence of metabolic mayhem in Step 1 are repeated in Step 3; this shows the effectiveness of your actions in Step 2 to heal your metabolism.

An essential component of Step 3 is *getting close to your optimal body weight*. Once metabolic mayhem becomes advanced, many people find it necessary to reach their optimal weight before gluconeogenesis can be controlled. The unpredictability of how excess weight will affect your transition from Step 2 to Step 4 of the Metabolic Masterplan Diet makes it impossible to predict whether you are ready to move on to Step 4. If you experience difficulty healing your metabolism, know that transitioning to Step 4 will suddenly become much easier when you near your optimal weight.

The Signs to Look For in Step 3:

- Blood sugar readings consistently indicate that fats and ketones are being metabolized.
- Metabolic biomarkers show signs of lasting improvement.
- You're steadily losing weight, which doesn't stop until optimal weight is achieved. Weight loss may be as much as 1 pound per day for the first week. After that, weight loss of 1-3 pounds per week is common until optimal weight is achieved. This varies considerably based on how strictly you follow the Metabolic Masterplan Diet.
- Cessation of sugar and carb cravings.
- You're not hungry after a few days at Step 2.
- You experience sustained energy while in Step 2.

If the above points *don't* apply, you must remain in Step 2 of the Metabolic Masterplan Diet until metabolic mayhem subsides.

Step 4: Increasing Your Fat Intake

Here's the litmus test to know if you can safely switch to Step 4 of the Metabolic Masterplan Diet: if your metabolic biomarkers, blood sugar readings, weight, food cravings, hunger and energy levels remain optimized *when you increase your fat intake*, you're home free and can safely transition from Step 2 to Step 4. But if these factors don't remain optimized when you make the switch, it's necessary to stay at Step 2 until your metabolism is more fully healed.

The Signs to Look For When Transitioning From Step 2 to Step 4 Include the Following:

- Your metabolic biomarkers remain optimized
- Your blood sugar readings remain optimized
- Your weight remains at optimal levels, give or take a few pounds
- You don't experience sugar or carb cravings
- You're not hungry between meals
- You have the same amount of energy (or more energy) as when you began restricting calories
- You experience a sense of vitality that may have been previously unknown (not everyone reports this experience)

If these points apply, you have successfully switched to Step 4 of the Metabolic Masterplan Diet. Congratulations! This is no small accomplishment in today's world. If the above points don't apply when you switch to Step 4, don't be discouraged! You can do this. I've helped many patients through this frustrating experience. If you're diligent with Step 2 of the Metabolic Masterplan Diet and still find that you're unable to successfully switch to Step 4, any of the following may apply:

- It's necessary to attain your optimal weight before moving on to Step 4
- It's essential to get more exercise to deplete your glycogen stores before moving to Step 4
- You may be consuming too much protein (this is explained in the Core Essentials Section)
- You must more fully heal chronic inflammation before you're able to switch to a fat-based diet
- You're dealing with underlying health issues that must be resolved before you can burn fats and ketones
- You've developed type 2 diabetes which must be healed before switching to the Metabolic Masterplan Diet

Note: most of the time I spend interacting with patients centers around helping them fully heal their metabolism so they can successfully switch to a fat-based diet, i.e., from Step 2 to Step 4. Therefore don't be surprised or disheartened if you have to put forth some effort to heal metabolic mayhem and switch to Phase 4. You're worth it, and all the energy you spend to better your health will pay lasting dividends. Don't confuse healing and taking care of yourself with struggle and hardship. Taking care of your life is an honor, not punishment.

Distinguishing Type 2 Diabetes From the Need to Remain in Step 2 Longer

If staying at Step 2 doesn't allow you to heal your metabolism, you may have developed type 2 diabetes. Once type 2 diabetes develops, metabolic biomarkers, especially blood sugar, become unpredictable, and losing weight can become arduous. So if your blood sugar readings remain unpredictable after meticulously following Step 2 of the Metabolic Masterplan Diet for 14 days—especially if your blood sugar remains unpredictable for 90 days—the likelihood that you've developed type 2 diabetes is high.

If this is the case, it's necessary to seek the help of a healthcare provider who can assist you with this serious healthcare matter. If your pancreas can no longer produce enough insulin to control the liver's production of blood sugar, remaining at Step 2 won't heal your metabolism until diabetes is properly managed and brought under control. Once type 2 diabetes is treated correctly, returning to Step 2 and resuming healing your metabolism is safe.

Keto Thirst—Does This Phenomenon Mean I'm Burning Fat and Ketones?

When you're in the initial stages of becoming fat-adapted, your glycogen stores will naturally become depleted. As your body burns through its glycogen, significant amounts of water and sodium are released into the blood, increasing urinary output. Another factor that contributes to keto thirst is *reduced insulin levels*. High insulin levels are associated with increased sodium retention. When your body switches to a fat-based metabolism, insulin levels plummet, contributing to sodium excretion in the urine[354].

Physiology is fickle, and it's impossible to predict the effects that depleted glycogen and reduced insulin levels will have on urinary sodium excretion rates. If you become thirsty, very thirsty or even lost-in-the-desert-on-a-horse-with-no-name thirsty, it's a sure sign that your body is excreting excess sodium as you switch to a fat-based metabolism. If this occurs, drink plenty of fluids and consume plenty of potassium, magnesium, and 500-1,000 milligrams of sea salt per day. Discontinue salt supplementation when keto thirst subsides.

Hydrate Before, During and After Switching to the MMD

Before you take steps to switch to the Metabolic Masterplan Diet, you must increase your water intake. To reiterate, don't simply increase your water intake, or you'll inadvertently become *more* dehydrated. In addition to increasing the *volume* of fluid you consume, it's critical that you also increase your intake of *electrolytes*: increase your potassium and magnesium intake before, during and after switching to your new diet.

Hydrating is different when you're burning fats and ketones instead of blood sugar. When your metabolism is healed and you're addressing the Short List, your body will retain less sodium than before. This is a beneficial effect of burning fats and ketones. As a result of retaining less fluid, however, you must be more diligent about staying hydrated once you switch to the Metabolic Masterplan Diet. You'll undoubtedly find that drinking more water is necessary when you're

fat-adapted. You'll also require more magnesium and potassium than when you relied on blood sugar as your primary fuel.

Low Sodium Levels May Cause a Strong Heartbeat

Excess sodium retention is associated with significant health issues, including *edema*, i.e., the retention of bodily fluids and sodium. In turn, edema causes high blood pressure and cardiovascular disease. When switching to a fat-based diet, sodium levels may become low for a few days or even weeks. This occurs as your body sheds excess water and sodium. Sodium levels are particularly likely to become low if you lose weight quickly. This is because a sizable percentage of initial weight loss is the excretion of excess bodily fluids; as these fluids are flushed from the body, excess sodium is also excreted in the urine.

When your metabolism heals and you draw near your optimal weight, your body will retain less water and sodium, and edema will become a thing of the past. As the amount of water and sodium in your body decreases and becomes optimized, your heart may beat more strongly and faster than usual for a few days. If this occurs, supplement with 500-1,000 milligrams of sodium daily until your heartbeat returns to normal. I've experienced "keto heartbeat" many times. This happened when I initially switched to a fat-based diet, and occurred a few times when I performed *a lot* of vigorous exercise on consecutive days. I consciously try to keep my sodium intake low; extreme exercise sometimes depletes my sodium stores. When this occurs, consuming 500-1,000 milligrams of sea salt daily returns my heartbeat to normal.

Get Plenty of Magnesium and Potassium Each Day

To recap, ensuring that your body has ample amounts of potassium (and magnesium) each day is essential. Potassium is abundant in the food supply, but most people still need to supplement with this essential micronutrient. Table 14 shows the amount of potassium in everyday foods. Determining the amount of potassium in the foods you typically consume lets you know if supplementing with potassium is right for you. Please refer to the Supplements, Vitamins, Minerals, Essential Micronutrients and Digestive Aids Section for detailed information about potassium.

Table 14: The Potassium Content of Common Foods

Salmon	292mg/3oz	Raw cream	250mg/oz
Grass-fed beef	243mg/3oz	Cheddar cheese	120mg/oz
Kale	329/cup	Pastured eggs	140mg/egg
Raw cabbage	260mg/50g	Coconut, dried	750mg/15g
Avocados	708/cup		

What to Do About Muscle Cramps

If you experience muscle cramps after switching to the Metabolic Masterplan Diet, it's necessary to increase your magnesium intake until the cramping subsides. Metabolizing fats and ketones dramatically reduces inflammation. As excess fluid accumulations (edema) are eliminated, you may experience muscle cramps. This is especially common during the night. Don't be afraid to supplement with 1,000 milligrams of magnesium daily, even as much as 2,000 milligrams per day if you're experiencing cramps. As your metabolism heals and cramps subside, gradually reduce your magnesium intake down to 1,000 milligrams per day.

Step 5: Optimizing Your Metabolism

Optimizing your metabolism is synonymous with making *lifestyle interventions,* i.e., simultaneously improving your diet, getting regular exercise and improving your psychological well-being. By simultaneously improving these three areas of your life, it's possible to improve your health in otherwise impossible ways. Healing is a deeply personal process of becoming a whole, integrated, healthy being. Healing involves every aspect of your life—biological, psychological and spiritual. Healing is the process, and optimization is the result.

It's More Than Physical... Because You're More Than Physical

Optimizing your metabolism is much more than a biological experience within your mitochondria. You can't see it or feel it happening within your cells, but the effects of optimized metabolism permeate every aspect of your being. Optimized metabolism doesn't happen by chance. It occurs when you focus on the Short List and make lifestyle interventions.

Optimization stems from a simple decision to optimize your metabolism, get plenty of exercise, destress, see life differently, grow, change, evolve, and overcome self-sabotaging behaviors. Optimization can only take place when something deep within you realizes that taking care of yourself is the best investment that you can make. Optimizing how every cell in your body produces energy begins with *a major shift in your mind*.

Optimizing Your Metabolism Means Exercising

Optimizing your metabolism means eating right, but it also means getting ample amounts of exercise. For example, Canada geese can fly up to 1,500 miles per day. American bison can run 30+ mph for over half an hour and jump a 6-foot fence. Male horned dung beetles can pull 1,141 times their body weight. Pronghorn antelope can maintain speeds of 60 mph for several miles. In stark contrast, humans have become increasingly sedentary, and it's common for adults to suffer from various health issues that interfere with exercise and movement.

By the 1950s, suburban-living, college-educated corporate workers accounted for a significant proportion of the American labor force[355], a trend that shows no signs of reversing. Whereas children once played outside, they now log several hours of screen time each day, a trend that begins in infancy[356]. Based on data published in the first-quarter 2018 Nielsen Total Audience Report, the typical American adult averages 11 hours and 27 minutes of daily media[357]. In sharp contrast to previous generations, modern humans get far less exercise throughout the day and are much more wired up—or wireless—as the case may be.

But the fact remains that to optimize your metabolism, you must exercise regularly. Exercise increases the number of mitochondria in skeletal muscle and staves off insulin resistance and aging[358]. Vigorous exercise strongly induces mitochondrial biogenesis (the creation of new mitochondria) in skeletal muscle[359], and moderate-intensity physical activity, when combined with weight loss, increases the number of mitochondria in skeletal muscle in previously obese adults[360]. It's almost impossible to overestimate the importance of regular exercise, especially in a world that has embraced a sedentary way of life. For more information on exercise, please refer to the Exercise Section.

Optimizing Your Metabolism Means Optimizing Your Psychology

Optimizing your metabolism means eating right, exercising and optimizing your psychology. Recall that psychology is the sum total of your mental, emotional, cognitive, behavioral and social characteristics. Psychology describes how we think, feel and behave in different situations. Optimizing your metabolism can only happen when a major shift happens in your mind to make only the healthiest choices for yourself on every level of your life. Thus optimization of any aspect of your life begins with a decision made in your mind, which can only occur when your psychology is healing. When you put forth the effort, life takes care of the rest.

The Biomarkers of Optimized Metabolism

Wouldn't it be great if you could gaze into a crystal ball and accurately predict the future? The reality is that it's hard enough to predict the weather for the next few days, let alone what your health will be like in 20, 30 or even 40 years. So rather than relying on crystal balls and psychics to predict your future health (I practiced in Sedona, AZ, for several years, where such things are common), rely on metabolic biomarkers. We can convince ourselves of many falsehoods, but metabolic biomarkers steer us in the right direction.

By now it's no secret that I'm a big fan of metabolic biomarkers. Metabolic biomarkers are the closest thing to peering into a crystal ball and predicting your future health. Unlike predictions from a crystal ball, however, those gleaned from metabolic biomarkers aren't shrouded in mystery. When we reviewed metabolic biomarkers earlier in this section, we touched on the fact that as your metabolism heals, most of your biomarkers will spontaneously optimize themselves. And while this is often the case, there are a few key metabolic biomarkers that it's particularly important to monitor to know that your metabolism (and overall health) is in tip-top shape. These include:

- NMR (nuclear magnetic resonance) —measures lipoprotein particles and cholesterol
- Hemoglobin A1c
- Insulin
- Ox-LDL
- Lp(a)
- The omega 3:6 ratio
- Homocysteine
- Methylmalonic acid (if indicated)
- Lp-PLA2
- Thyroid hormones (please see the Thyroid Physiology and Iodine Section)
- Ectopic fat (assessed via a liver ultrasound)
- DEXA scan

Of course, paying close attention to all metabolic biomarkers is essential, but in the game of optimization, these biomarkers merit unique consideration. Please refer to Metabolic Biomarkers for more information on these and other biomarkers.

Summing up Healing and Optimizing Your Metabolism

When you focus on healing, optimization will occur naturally. Healing is a series of actions to rebuild your health and get back on track. Once the healing process has been started, optimization gradually springs forth like warmth from a fire. Healing includes specifics such as bringing your insulin, triglycerides, blood sugar and body fat stores within healthy limits. Importantly, healing also involves upgrading your psychological software. Most of us continue to run our lives with outdated operating systems and software programs that directly affect our health. Healing can only happen when we upgrade our psychological software and eliminate the programs that have done nothing but lead us in the wrong direction and crash our systems.

Healing and optimization aren't just highfalutin concepts. They're *practical*. When you put forth the energy to heal and optimize your metabolism, the chances that you'll live longer, live healthier and enjoy your life more increase exponentially. You can have everything that this world values, but if you don't have your health, each day is an ironic reminder that what matters most isn't stuff, it's a healthy mind and body. The formula of healing and optimization includes being judicious with your diet, getting plenty of exercise, destressing and paying close attention to your psychology, and detoxifying your body.

What's Next?

Now that we've covered metabolism in detail, the next step is to learn about the Core Essentials—the protein, fat and fiber that forms the basis of both phases of the Metabolic Masterplan Diet.

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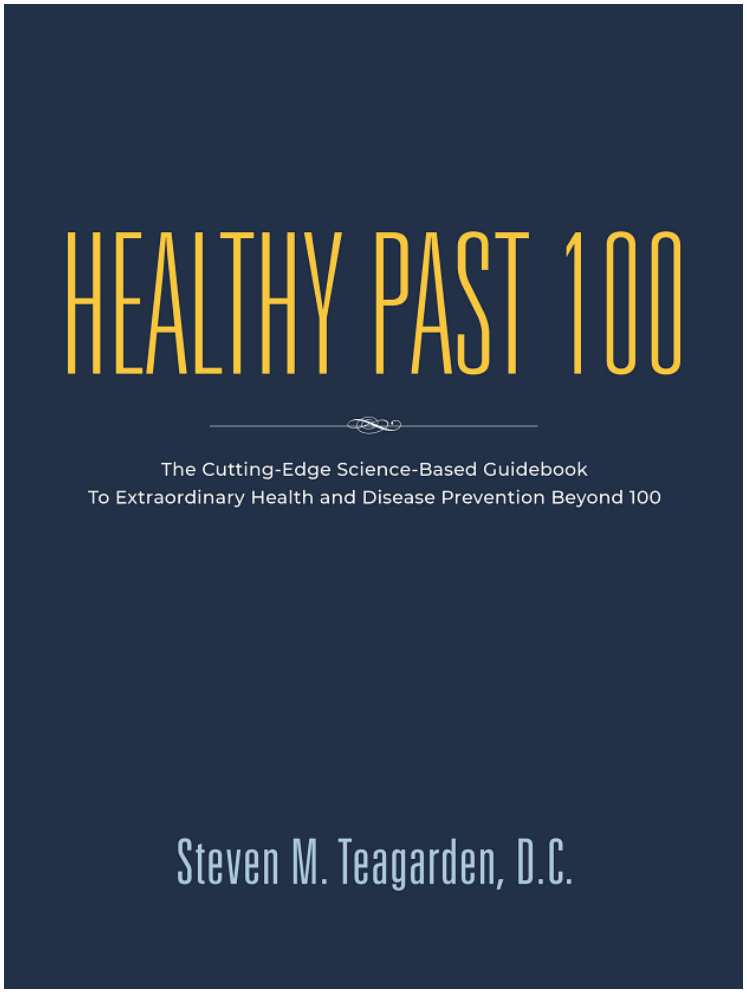

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