Fat vs Carbohydrate as Fuel

Summary

Humans have been hard-wired through environmental selection pressure to prefer fat as their primary fuel source from both storage and from dietary sources. Our preference for fat burning contrasts sharply with conventional wisdom that suggests carbohydrates should form the foundation of a healthy diet. The modern high-carbohydrate, grain-based diet has created a dependency on external carbohydrates for energy at the expense of efficient fat metabolism. This causes us to struggle to maintain stable energy levels since we are so heavily reliant upon a steady supply of ingested calories for energy.

Instead of taking advantage of our abundant fat stores, and assorted other internal mechanisms for energy production (e.g., stored glycogen, gluconeogenesis, ketone production), this high-carbohydrate eating pattern stimulates chronically excessive insulin production. With insulin chronically elevated to deal with the genetically unfamiliar high-carbohydrate eating pattern, abundant sources of energy are locked away, and inaccessible, in fat cells and other cells. Furthermore, a high-carbohydrate, high insulin-producing diet is pro-inflammatory, immunosuppressive, and hormone balance disrupting, which increases the risk of assorted health problems and serious disease.

The glucose requirements of your muscles and organs can be more than satisfied by a reasonable intake of primal foods that contain carbohydrates (vegetables, fruits, nuts, and seeds) as well as the internal processes of gluconeogenesis (conversion of amino acids into glucose) and ketone production in the liver. Ketones are fat metabolism by-products that are produced when carbohydrate intake is very low. Ketones are utilized by the body in the same manner as glucose, making this internal energy source
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a highly effective, clean-burning substitute for the energy provided by ingested carbohydrates.

Reprogramming your genes to become efficient at fat and ketone burning can lessen your reliance on external sources of carbohydrates for energy, sparing the fight-or-flight response from abuse and minimizing the breakdown of lean muscle tissue into glucose for quick energy, a process that occurs frequently in a sugar burner since stored energy is not readily accessible.

Primal-aligned eating habits can improve caloric efficiency, the ability to survive and thrive on fewer ingested calories. This is preferable to speeding up metabolism, because an accelerated metabolism and an accordant acceleration of cell division can increase cancer risk and shorten lifespan.

The Spartan Method Health Coaching program does not promote a rigid macronutrient intake plan. Instead, one must obtain an average daily intake of protein that supports the preservation of lean muscle mass, limit carbohydrate intake to 150 grams per day or less on average, and optimize fat intake to promote satiety and maximum dietary satisfaction.

Quick Facts

1. Humans have burned fat as their primary source of energy throughout human evolution, until civilization's abrupt transition to a grain-based diet that started around 10,000 years ago.
2. A high-carbohydrate, high insulin-producing diet inhibits fat metabolism, making you dependent upon regular carbohydrate feedings to sustain energy. This promotes a lifelong accumulation of excess body fat, an exhaustion of the fight-or-flight stress response, and emotional difficulties related to eating and struggling to balance calories in with calories out.
3. A high-carbohydrate diet promotes inflammation and free radical damage in the body, accelerating the aging process and contributing to all manner of health problems, including heart disease and cancer.
4. Genes can be reprogrammed in approximately 21 days by restricting carbohydrate intake and training the body to optimize the burning of fat and ketones as its primary energy sources.
5. There is no requirement for dietary carbohydrate in human nutrition. Humans can live on minimal to no carbohydrate intake for prolonged periods, and have done
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so throughout history. If necessary, your body could meet its glucose needs through the internal energy manufacturing processes of gluconeogenesis and ketone production.

6. Ketones are byproducts of fat metabolism in the liver when glucose and insulin levels are low. They are an excellent alternative to glucose as an energy source, and in fact are burned more efficiently by the brain and heart than is glucose. Ketones have played a key role in human survival, shoring up energy deficits when food intake (particularly carbohydrate intake) fluctuated over the course of human evolution.

7. Dietary fats come in assorted forms, some healthy and some not. Saturated fats, often maligned by conventional wisdom, are an excellent source of energy with no adverse health effects. Chemically altered fats and excess intake of omega-6 polyunsaturated fatty acids (particularly when coupled with insufficient omega-3 intake) are the driving factors in serious diet-related health problems, such as heart disease and cancer.

8. Consuming a daily average of 150 grams of carbohydrates or less enables an abundant intake of nutrient-rich vegetables, along with a sensible intake of seasonal fruit, nuts, dark chocolate, and other foods with moderate amounts of carbohydrates. Carb intake at this level enables lifelong weight management and protection from disease risks.

More Facts

Standard American Diet:

Ever since the cultivation of grains led to the transition away from hunter-gatherer living and into civilization, humans have favored a carbohydrate-dominant diet. Grains are an easy food to grow, store, and prepare, enabling a society to live in one place, specialize labor, and escalate technological progress. Unfortunately, the progress of civilized life has come at the expense of health, since a diet high in carbohydrates is a serious affront to our genes. We evolved over millions of years to prefer hunter-gatherer fare, which is by comparison extremely low in carbohydrates.

Consuming a high-carbohydrate diet creates a vicious cycle of dependency on carbohydrates for energy. This is because ingested carbohydrates are immediately burned for energy, with the excess transported by insulin into the muscle and liver cells for storage as glycogen, and, when glycogen storage is maxed out, the remainder of

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those ingested calories head into fat cells for storage. The insulin surge triggers a decline in available energy in the bloodstream, thereby activating an appetite for more quick energy carbs. Meanwhile, internal sources of energy remain untapped, overriding our genetic preference to burn fat without depending on regular meals.

Since fat metabolism is compromised by a pattern of high insulin-producing meals, the major energy variable becomes your next meal. Attempting to balance energy and maintain ideal body composition with carbohydrate as the primary fuel source contributes to burnout (chronic and abusive stimulation of the fight-or-flight response), lifelong weight gain (can't burn stored body fat efficiently), and disease patterns (excess glucose and insulin promote oxidation and inflammation) that are epidemic in modern life.

Carbohydrate Dependency Drawbacks:

Consider the conventional wisdom assumptions that:

● breakfast is the most important meal of the day;
● that you need caloric energy to transition from a sleeping state of minimal caloric requirements into the demands of a busy day;
● that you must balance the glycemic response of your meals to deliver a steady supply of blood glucose by consuming whole grains and other starchy or fibrous foods (which take longer to convert into glucose than highly refined foods such as sugar and sweetened beverages);
● that, following your power breakfast, you must engage in strategic snacking to sustain optimal blood sugar levels;
● and that you must generally eat meals of reasonable portion sizes, at regular intervals, to keep the metabolic fire stoked and balance the all-important equation of calories ingested to calories burned.

From a metabolic standpoint, all of these assumptions become literally true, but only within the paradigm of a high-carbohydrate diet. When you are reliant upon external sources of energy and exist in a state of hyperinsulinemia (chronically elevated blood insulin levels), you inhibit your ability to access stored energy and are compelled to play the blood-sugar-balancing game as described. This has proven difficult to manage and ineffective for weight loss; not to mention it dramatically increases one's risk of disease.

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Fuel Partitioning:
At any given time we are burning a mix of fatty acids, protein (amino acids), glucose (from carbohydrate), and ketones. The levels we burn at any given time depend on our metabolic efficiency and gene expression preferences, our dietary habits (particularly our level of insulin production), and our exercise habits. The way we partition fuel is an example of the gene expression discussed in Module #1. For example, high carbohydrate intake and high insulin production down-regulate the genes involved in fat metabolism and up-regulate the enzyme systems and pathways involved in glucose burning, as well as the conversion and storage of excess ingested calories in the fat cells.

In contrast, moderating carbohydrate intake in favor of a comparatively high-fat diet will up-regulate the genes involved in burning both stored and ingested fat, and also normalize appetite and hunger patterns. The latter is due to the regulation of the hormones that affect appetite, such as leptin (controls satiety and whether your body burns or stores fat), CCK (mediates the rate of digestion in the small intestine), ghrelin (stimulates hunger and can act as a counter to the satiety influence of leptin), and lipase (influences fat metabolism).

When carb intake and insulin production are excessive, leptin signaling is suppressed and ghrelin levels are chronically elevated. This leads to excessive appetite and caloric intake, greater reliance on glucose for energy needs at the expense of fat, and a greater propensity to store ingested calories as fat rather than burn them for energy. In a primal-aligned pattern of eating, partitioning of fat and ketones predominates, and glucose needs diminish. Referencing the example of a high-carbohydrate eater missing a meal and triggering the fight-or-flight response, a primal-adapted eater who misses a meal will simply up-regulate fat and ketone burning in the absence of ingested calories.

Primal-adapted, Fat-adapted, Keto-adapted:
This describes a state in which fat- and ketone-burning genes are up-regulated as a consequence of primal eating habits, particularly the restriction of excess carbohydrates to enable efficient burning of stored body fat as a primary energy source, and the production of ketone bodies as an alternative fuel source.
21-Day Transformation:

Twenty-one days is the estimated time required to become keto- and fat-adapted by eating primally. Transformation may take longer in those who have a history of gene mismanagement and have sustained metabolic damage from prolonged, excessive carbohydrate intake and insulin production. In the event of difficulty, a more gradual reduction of carbohydrate intake can be attempted (i.e., beyond 21 days) until intake in the optimal primal maintenance zone of 150 grams per day or less is attained.

Glucose:

Glucose is an energy source for muscles, brain, and red blood cells; it is derived from dietary carbohydrate or gluconeogenesis the conversion of amino acids into glucose. All forms of ingested carbohydrate, from simple sugars to complex starches, are converted into glucose by the liver. Then, they are either:

- burned for fuel immediately
- stored as glycogen in the liver and muscles
- or converted into triglyceride and stored in the fat cells.

The body's storage form of glucose is glycogen, since it is more space efficient and less oxidative than glucose itself. Glycogen storage capacity is limited. The liver can store around 100 grams of glycogen, while the muscle tissue can store another 350-500 grams.

Glucose is the preferred fuel for muscles exercising at medium to high intensity, and the brain relies primarily on glucose to function. These biological facts have inspired conventional wisdom to encourage a high-carbohydrate diet. However, glycogen stores in the body are extremely limited in comparison to fat stores; glucose supplies are burned through quickly (making it easy to over-consume glucose and store the excess as fat), and a pattern of excess glucose intake beyond our genetic expectations promotes systemic inflammation and disease.

Chronically high levels of glucose in the bloodstream damage organs by promoting the production of reactive oxygen species (ROS: aka "free radicals" that contain oxygen molecules) in cells. Particularly susceptible are the longer-lasting cells in the body, such as those that comprise the cardiovascular system, the elastin and collagen cells in your skin), pancreatic cells (pancreatic beta cells control insulin release), brain cells,
retinal cells, and renal (kidney) cells. For example, diabetics, who have difficulty regulating blood glucose, frequently suffer from vision and kidney problems, because retinal and renal cells have poor internal antioxidant defense mechanisms. Relying on glucose as a primary energy source (a consequence of a high-carbohydrate diet) can result in compromised health via increased free radical production (oxidation), inflammation, and suppressed immune function.

Glucose Requirements:
The brain and other organs require around 150 grams of glucose per day to sustain basic functions. Becoming fat- and keto-adapted by eating primally can reduce dietary glucose requirements down to around 50 grams per day. This minimizes the need to consume carbohydrates for the sake of carbohydrates. In fact, your daily glucose requirements can be more than fulfilled by the abundant consumption of nutrient-rich vegetables foods that should be consumed for their health properties unrelated to their carbohydrate content.

The body can manufacture glucose or glucose-alternative fuel (ketones) to sustain health and energy levels when dietary carbohydrate intake is low. The liver is able to manufacture up to 150 grams per day of glucose through gluconeogenesis. Twenty grams per day can be manufactured from glycerol (a by-product of fat metabolism), and ketones can provide an efficient alternative fuel source for brain, heart, and skeletal muscle accustomed to burning glucose. These internal mechanisms provide more than enough energy to sustain basic metabolic needs each day regardless of dietary contributions.

Glycation:
Glycation is the binding of excess glucose molecules in the bloodstream to protein molecules, which damages assorted structural components of organs and tissues in the body at the DNA level. The process of glycation is driven strongly by the consumption of excess carbohydrates in the Standard American Diet.

Glucose molecules are toxic in the bloodstream, causing the body to become overwhelmed by chronically elevated carbohydrate intake. These blood-borne glucose molecules are literally "sticky," like the sugary or starchy foods they originate from.
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Hence, they are prone to bind with important structural protein molecules throughout the body and wreak havoc on normal function.

Glycation can be caused not only by consuming excess carbohydrates to produce chronically elevated glucose levels in the bloodstream, but also by overcooking food, and by smoking cigarettes. Smoking exacerbates the glycation process, particularly in the lungs and cardiovascular system, dramatically increasing the risk of cancer in these organs. Cooking food to the point of browning or blackening destabilizes the protein molecules, vitamins, and other nutrients by binding glucose to proteins during the cooking process and forming AGEs: Advanced Glycation End-products (details follow). When you ingest glycated food, you introduce these damaged protein molecules into your bloodstream, accelerating the aging process by external means.

AGEs:

Advanced Glycation End-products, or glycotoxins, are created by a chain of chemical reactions that follow the initial glycation reaction between glucose and protein molecules. These agents wreak havoc on healthy cellular function. AGEs are produced internally, as in a pattern of chronic hyperglycemia (excess glucose in the bloodstream), or externally, by prolonged and excessive high-temperature cooking. While high-fat animal products and nuts have higher levels of AGEs than common carbohydrate foods do, it is the excess consumption of carbohydrates resulting in chronically elevated blood glucose levels that is the driving factor in the production of AGEs in the body. Fructose in particular promotes the formation of AGEs.

AGEs cause cellular damage, promote oxidation and inflammation in the bloodstream, and are believed to be one of the primary contributors to accelerated aging. AGEs are also believed to suppress the production of internal antioxidants, such as glutathione, super-oxide dismutase (SOD), and catalase. These antioxidants fight free radical damage on the front lines inside your body, are critical to good health, and help make up for antioxidant deficiencies in the diet.

Gluconeogenesis:

Gluconeogenesis is the conversion of amino acids into glucose by the liver (Latin for "sugar-new-make"). Gluconeogenesis delivers an immediate burst of glucose energy into the bloodstream, and is a central element of the "fight-or-flight" response the heightened state of arousal and performance by all the body systems to counter a life
or death threat. Gluconeogenesis can either utilize ingested amino acids for conversion into glucose, or use lean muscle tissue to convert into glucose. The latter is clearly undesirable and indicative of a catabolic process that compromises long-term health in the interest of immediate survival.

On a carbohydrate-dependent diet, gluconeogenesis can often be catabolic, because declines in blood glucose are frequent (due to the excess carb intake/insulin production roller coaster), and perceived as stressful events by the body. This occurs when one is locked in a carbohydrate-dependent metabolism a decline in blood sugar causes a perceptible drop in energy and focus (and an increase in appetite), because fat and ketones are not readily accessible as energy sources.

In a primal-aligned diet, gluconeogenesis can be an elegant way to "top off the tank" for your body's glucose requirements by converting ingested amino acids into glucose and sparing lean muscle tissue. This favorable distinction is enabled because blood sugar levels are more regulated when eating primally, so gluconeogenesis is called upon less frequently and at a milder, non-emergency level. This is also the case because a fat-dominant metabolism enables the production and utilization of ketone bodies as a fuel alternative to glucose.

Fat:

Fat has been the primary fuel source for humans for 2.5 million years, both from storage and as the predominant macronutrient in the human diet. In fact, it was the energy-rich, high-fat elements of animal products (particularly omega-3 fatty acids) that facilitated the development of a more complex brain that allowed humans to branch out from their predominantly vegetarian great ape cousins and eventually rise to the top of the food chain. Fat is a nutrient-dense source of fuel at nine calories per gram. By comparison, carbohydrates and protein each deliver four calories per gram. The energy provided by ketones is five calories per gram, while alcohol comes in at seven calories per gram.

Fats are compounds of carbon, hydrogen, and oxygen atoms that exist in chains of varying lengths, shapes, and orders. They are present in the body in two different molecular forms. Free fatty acids are the molecules that flow in the bloodstream and are available to burn for fuel. Triglycerides are the storage form of fat in the fat cells comprised of three fatty acid molecules bound together by a glycerol molecule.
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Triglycerides are too large to exit the membrane that surrounds the fat cells. In order for triglycerides (stored fat) to be released from storage and deposited into the bloodstream for use as energy, triglycerides must be broken down into their component molecules; in other words, "freed" from triglyceride into free fatty acids.

Insulin is the primary hormone that regulates whether fatty acids are available in the bloodstream for burning, or locked away inside fat cells as triglycerides. A high insulin-producing diet causes excess ingested carbs to be converted into triglycerides, as well as ingested fats to be converted into triglycerides. In this example, despite adequate caloric intake, the bloodstream is starved for energy because ingested carbohydrate and fat calories are quickly ushered out of the bloodstream by insulin and locked away in fat cells as triglycerides.

Dietary Fats:

Dietary fats come in different forms, offering an assortment of health benefits and in some cases compromising health. Dietary fats are commonly distinguished by whether they are solid at room temperature (known as "saturated") or liquid (known as "unsaturated"). Many fats contain a blend of different types of fat molecules. For example, olive oil is commonly characterized as a monounsaturated fat because it contains 78 percent monounsaturated fatty acids, but it is also comprised of 14 percent saturated fatty acids, and 8 percent polyunsaturated fatty acids.

Saturated Fat:

With saturated fats, all potential bonding sites on the carbon atoms of the fatty acid chain are occupied by hydrogen; hence the term "saturated." Saturated fat, often erroneously maligned by conventional wisdom as contributing to the heart disease process, is an excellent source of caloric energy with no known adverse health effects. Saturated fats contribute to critical metabolic functions, including enhanced nutrient absorption and immune function, and protection against oxidative damage (our cell membranes are made out of saturated fat). Only when saturated fats are consumed in the presence of excessive carbohydrates, such as with the Standard American Diet, can they be potentially troublesome.

Saturated fats are commonly found in animal foods (meat, eggs, butter, cream) or in certain tropical oils, such as coconut and palm. They are extremely temperature stable and thus resistant to oxidative damage when they are exposed to heat, light, or
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This makes saturated fats such as butter, lard, and coconut oil the preferred choices for cooking.

Monounsaturated Fat:
These fats contain a single double bond ("mono") in their fatty acid chain. Monounsaturated fats are universally regarded as healthy, lauded for enhancing cardiovascular and immune function and offering protection against heart disease. Good sources of monounsaturated fat include macadamia nuts, avocado, olives, and extra-virgin olive oil. They are less temperature stable than saturated fats and thus should not be used for high-temperature cooking. However, olive oil can tolerate mild warming temperatures without oxidizing.

Polyunsaturated Fat:
These fats contain more than one double bond in their fatty acid chain. The more double bonds a fatty acid contains, the more fluid it is. Hence, these oils retain their liquid form at room temperature and even when refrigerated. However, polyunsaturated fatty acids (PUFAs) are highly susceptible to damage from even routine exposure to light, heat, and oxygen, something that commonly occurs during the manufacturing process, not to mention when they are used for cooking!

The most common form of PUFA in today's diet are vegetable seed oils, such as canola, corn, soy, safflower, and sunflower. Other high PUFA foods include butter-like spreads, salad dressings, and assorted packaged and processed snack foods made with these offensive oils. Cooking with a PUFA oil like canola oil produces significant oxidative damage to the molecules. The endocrine system is especially vulnerable to the ingestion of oxidized PUFA, which can lead to disruption in healthy hormone and immune function.

Omega-6 to Omega-3 Ratio:
Polyunsaturated fatty acids are divided into two categories of essential fatty acids ("essential" meaning fat we cannot manufacture internally and must obtain from the diet): omega-6 fatty acids and omega-3 fatty acids. The dietary ratio of omega-6 to omega-3 fatty acids has become a popular topic in evolutionary health circles. The main concern is insufficient intake of omega-3s, which are widely regarded as healthful and anti-inflammatory, coupled with an excess intake of omega-6s, which are widely regarded as pro-inflammatory.

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Breaking research suggests that this may be an oversimplification of the issue; that in fact both omega-6 and omega-3 have anti-inflammatory properties. However, omega-3s have a stronger anti-inflammatory effect.

When we ingest linoleic acid, the primary omega-6 fatty acid it converts into arachidonic acid (AA), generally a precursor for inflammatory cytokines and thus labeled "pro-inflammatory." When we ingest Alpha-linoleic acid (ALA: the plant form of omega-3 fatty acid), it converts into the anti-inflammatory precursors EPA and DHA (as seen on fish oil capsules). These conversions happen on the same enzymatic pathways, so they are competing for limited access to our cells. When we consume an excess of linoleic acid, our conversion of ALA into EPA and DHA is compromised, leading to a potential inflammatory imbalance. However, this imbalance can be countered with direct consumption of foods or supplements high in EPA and DHA, such as oily, coldwater fish, pasture-raised animals and eggs, or high quality fish oil supplements.

The Standard American Diet (SAD) high in grains, vegetable and seed oils, and chemically altered fats brings numerous health objections, particularly the fact that these foods have minimal nutritional value and cause oxidative damage in the body. Industrial oils, processed grain-based snacks, and CAFO (Concentrated Feeding Operation or Factory Farming) animals all happen to be high in omega-6, contributing to a high ratio of omega-6 to omega-3. Again, the ratio could be of secondary concern to the lack of sufficient omega-3 intake and the excessive intake of unhealthy foods that happen to be high in omega-6. For example, it's estimated that the Standard American Diet obtains around 70% of its (mostly omega-6) polyunsaturated fatty acids from industrial oils, shortening, and margarine. Only small percentages of total omega-6 intake come from nuts, seeds, beans, and animal products. Consequently, omega-6 fatty acids should not been seen as unhealthy per se, but rather that the elevated omega-6 to omega-3 ratio is a symptom of poor dietary habits, and that much of our omega-6 fatty acids come from rancid oils, fast food products cooked in oil, packaged snacks and treats made with shortening/partially hydrogenated oils, and other processed foods high in sugar and industrialized oils.

Both omega-6 and omega-3 fats are "essential" to consume to promote a healthy inflammatory balance, among other functions, in the body. It's also important to keep in
mind that "inflammation" is not entirely bad either. The inflammatory process is a critical element of healthy immune function and the fight-or-flight response for peak performance. Brief bouts of inflammation triggered by high intensity exercise helps build fitness and promotes optimal gene expression. Similarly, the inflammation that occurs at an injury site (sprained ankle, bee sting, black eye) allows the cellular damage to be contained in that one area instead of circulating throughout the bloodstream, and also speeds the healing process by increasing blood flow and accelerating the removal of waste products in that area.

It is only when inflammation is chronic or system-wide that health is compromised and risk is elevated for high blood pressure, coronary artery disease, depressed immune function, sub-optimal neurological function, and many other health problems and serious diseases. Chronic or systemic inflammation is caused by poor dietary habits (too many processed foods, too little omega-3 intake), and high-stress lifestyle behaviors such as excessive exercise, insufficient sleep, and poor work/leisure balance.

**Omega-3 fatty acids:**
These fats are named for the hydrogen double bond at the third carbon in the fatty acid chain. Lauded for enhancing cardiovascular, brain, skin, and immune function, omega-3s help moderate systemic inflammation, increase insulin sensitivity, and reduce the risk of heart attack, arthritis, autoimmune disorders, and cognitive problems such as depression, ADHD, and Alzheimer's. Omega-3s are found in highest concentration in oily, coldwater fish (SMASH hits of salmon, mackerel, anchovy, sardines, herring). Pasture-raised eggs and animal meats are also good sources of omega-3s, as are leafy greens. Nuts and seeds contain significant levels of omega-3s as well, but are invariably higher in omega-6 than omega-3.

**Omega-6 fatty acids:**
These fats are named for the hydrogen double bond at the sixth carbon in the fatty acid chain. Omega-6 fats from nutritious foods offer assorted health benefits, but unfortunately the excess consumption of these fats (along with insufficient omega-3 intake) via unhealthy food sources is common. Omega-6 fatty acids are found in healthy foods such as nuts and seeds, but also in vegetable oils, conventionally raised animals fed grain-based diets, bakery items (donuts, cookies), and all manner of processed, packaged, and frozen foods.
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Hunter-gatherer references:

It's commonly mentioned that our hunter-gatherer ancestors had an omega-6:omega-3 ratio of 1:1, or at least 2:1. This was due to the absence of eating the aforementioned high omega-6 processed foods and the likelihood of obtaining higher levels of omega-3s from typical hunter-gatherer fare. Today, the typical SAD eater has an estimated ratio of 20:1 or even worse. While this gross imbalance in comparison to our hunter-gatherer ancestors presents a compelling sound bite, it's best to focus on the big picture task of increasing omega-3 intake for the broad health benefits (especially the anti-inflammatory effects), along with eliminating unhealthy foods that happen to be high in omega-6 to protect yourself from oxidative damage.

Partially Hydrogenated Trans Fats:

Hydrogenation is a process by which an unsaturated fat (typically a vegetable oil) is heated to a high temperature under extreme pressure and mixed with toxic metallic solvents to saturate the carbon bonds with hydrogen and render the fat solid at room temperature.

"Trans" refers to the presence of hydrogen on both sides of the carbon chain. Trans fats also occur naturally in certain foods such as cow's milk and meat, in trace amounts. In their natural form, they are known as conjugated linoleic acid (CLA) or vaccenic acid. These natural trans fats are healthy to consume. The process of hydrogenation creates a trans fat of distorted shape, rendering the molecule straighter than its natural, slightly bent, composition. Since the process of hydrogenation alters fat molecules into the trans form, all partially hydrogenated fats are trans fats, but not vice versa. The creation of a trans fat can be considered an undesirable side effect of the partial hydrogenation process. To distinguish between the healthy, natural trans fats found in whole foods and the chemically altered partially hydrogenated trans fats discussed here, we will refer to the latter as "partially hydrogenated trans fats", or "chemically altered trans fats" for the duration of this section.

Chemically altered trans fats are easily oxidized to form free radical chain reactions that damage cell membranes, promote systemic inflammation, obesity, immune system dysfunction, the oxidation and inflammation process that characterizes heart disease, and many other serious health problems. These chemically altered trans fats are unable to be metabolized normally by the body, but your body is fooled into
incorporating these agents into fat-based cell membranes. Incorporating dysfunctional synthetic fat molecules into your cell membranes contributes directly to inflammation, aging, cancer, and heart disease. Medical experts estimate that as many as 100,000 premature deaths from cancer and heart disease annually can be directly attributed to the routine consumption of trans fats in the Western diet.

The ingestion of a simple order of French fries (typically manufactured with oxidized vegetable oils in fast food joints, or perhaps partially hydrogenated fats in frozen foods) causes an immediate disruption in the normal dilation of arteries that occurs in response to exercise, and that this disruption in healthy cardiovascular function can last for up to 24 hours. Oxidized and chemically altered oils are top priority to eliminate from diet because they inflict direct damage at the DNA level (just like exposure to radiation).

Chemically altered trans fats are found in the majority of conventionally processed, packaged, frozen, and fast food products (for example, crackers, chips, cookies, pastries, donuts, shortening, and deep-fried fast foods).

Ketones:
Ketones, aka ketone bodies, are by-products of fat metabolism in the liver when blood glucose and blood insulin levels are low. Ketone production starts with the absorption of ingested fats in the small intestine, where glycerol molecules separate from fatty acid molecules. After absorption, some glycerol travels to the liver, where it undergoes gluconeogenesis and is converted to glucose again, in the absence of glucose in the bloodstream. Most fatty acids travel to the liver too, where they are broken down into ketones.

The conversion rate of fat into ketones in the liver depends on how much glucose is in the bloodstream. A single liver hormone known as FGF21 is responsible for the oxidation of fatty acids into ketones in the liver. When glucose levels are high, ketone production is suppressed. In this circumstance, the body deems it unnecessary to manufacture ketones due to the abundance of glucose to burn. Hence, the ingestion of a single high-carbohydrate snack or meal will abruptly shut down ketone production and the body will burn the ingested carbohydrates as glucose. When blood glucose levels are low, such as when fasting or awakening in the morning after not eating for
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many hours, ketone production is turbocharged as the body welcomes the production of an alternate energy source to satisfy its baseline glucose requirements.

Brain, cardiac, and skeletal muscle cells can run just as effectively on ketones as they can on glucose, and may even prefer using ketones for fuel. While ketones are mostly generated in the liver, the astrocytes in the brain can also generate ketones for use by neurons. The brain does have an absolute baseline minimum requirement for glucose estimated to be between 20-50 grams per day that must be met one way or another. This can be through dietary carbohydrate intake, or through gluconeogenesis, or from glycerol. However, the brain is capable of burning around 120 grams per day of glucose, especially if you are not fat- or keto-adapted. Even in the case of a fat- and keto-adapted individual, the absolute glucose requirement in the brain is relevant, but glucose doesn't have to come from dietary carbohydrates.

In summary, ketones can be an excellent alternative fuel source for those who are adapted to burning them through a pattern of eating that moderates insulin production.

Ketosis:
Ketosis literally means that the body is accumulating ketones in the bloodstream faster than they are being burned. A state of ketosis is not at all dangerous or unhealthy. To distinguish between the dangerous health condition of ketoacidosis, some health experts characterize this optimal state as benign dietary ketosis. However, it is more desirable to be keto-adapted to the extent that you efficiently burn ketones instead of excrete them in the urine and breath. A telltale sign that excess ketones are being excreted is the odor of acetone on the breath. Technically, you could characterize the optimal state as a "ketone-burning state," a "keto-adapted state," or a state of "nutritional ketosis," meaning the body is effectively burning ketones to supply nutritional needs.

Ketoacidosis:
A pathological state in which ketone production is wildly excessive and uncontrollable, leading to dangerous acidity levels in the bloodstream. This condition is usually experienced by type 1 diabetics or alcoholics with damaged livers, and populations that are unable to produce insulin normally and are thus at risk of developing dangerous blood acidity levels. While nutritional ketosis is represented by a concentration of 0.5 to
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3.0 mg/dL in the bloodstream, and starvation ketosis is represented by levels of 3.0 to 6.0, ketoacidosis is reflected by blood levels over 15 mg/dL.

In normal, healthy individuals with functional livers and insulin systems, ketone production is regulated at safe levels vastly below a danger threshold. When ketone bodies accumulate in the bloodstream, insulin is released to moderate them to safe levels, and excess levels are excreted in the urine before they dangerously impact the acid-alkaline balance in the bloodstream.

Type I diabetics at risk of ketoacidosis might produce and accumulate ketones at 10 times or greater a level than keto-adapted eaters might experience due to the dysfunction of diabetic insulin mechanisms. The lack of full understanding by the general public and nutritional conventional wisdom regarding the role of ketones has led to an inaccurate association between normal, healthy ketone burning and the health risks associated with ketoacidosis risks relevant only to the aforementioned high-risk medical populations. It is more accurate to refer to this pathology as "diabetic ketoacidosis" or "alcoholic ketoacidosis."

Keto-Adapted:
Indicates the ability to burn ketones efficiently, thanks to up-regulation of keto- and fat-burning genes. Being keto-adapted enables you to spare muscle protein from being stripped via gluconeogenesis, as it might be by someone who suddenly restricts carbs or total calories on a crash diet and is not yet keto- or fat-adapted. In the latter case, gluconeogenesis will be called upon too frequently and too severely. Drops in blood glucose associated with skipping meals or extreme dieting will be perceived as a stressful event by the body, and the endocrine system will initiate the fight-or-flight response. The primary stress hormone cortisol will promote the conversion of amino acids into glucose to sustain energy levels, often stripping lean tissue to obtain the necessary amino acids. Ketone bodies will be produced but poorly utilized. Instead, they will be excreted through urine and breath, leading to the familiar condition of "ketone breath" in crash dieters who are not keto-adapted.

In a keto-adapted individual, glucose needs will be less pronounced as fatty acids and ketone bodies provide ample energy. The comparatively minimal glucose requirements of a fat- and keto-adapted eater will be supplied by gluconeogenesis, which typically converts ingested amino acids into glucose instead of stripping lean muscle tissue.

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These elegant internal production mechanisms have served humans well for 2.5 million years of extreme fluctuations in food availability yet continual demand for activity, including spontaneous bouts of intense efforts. Besides the fat metabolism benefits, a ketogenic diet is believed to help cancer patients moderate the growth of tumors. Since cancer cells feed off glucose, starving the body of glucose puts the brakes on unregulated cell division and improves cell repair processes.

Keto-adapted athletes:

In the case of hard-training athletes and other high-calorie burners who frequently deplete muscle glycogen stores, conventional wisdom strongly advocates consuming ample amounts of carbohydrates to boost performance during sustained efforts and to restock muscles quickly with more carbohydrate immediately after exercise. This premise is validated biochemically when a high-carbohydrate diet is followed. A carb-dependent athlete will indeed burn through significant glycogen during a medium-to-difficult intensity sustained workout, and need to immediately refuel afterwards to promote recovery and prevent muscle catabolism.

However, by following a primal-aligned, low insulin-producing eating pattern and training in a primal-aligned manner that avoids chronic exercise patterns, an athlete can become keto-adapted to the extent that he or she develops a reduced need for glycogen/glucose during sustained endurance exercise for fuel, and a reduced need to replenish carbs after exercise. Ketone-burning and fat-burning efficiency not only provides stable fuel sources for prolonged efforts at low to medium intensity, but also spares the conversion of lean tissue into glucose via gluconeogenesis, as might be the case when a carbohydrate-dependent athlete runs low on glycogen/glucose and is unskilled at burning fatty acids or ketones.

The exercise pattern recommended by the Spartan Method blending low-intensity cardio with brief, high-intensity strength and sprint workouts demands fewer dietary carbohydrates than a chronic exercise pattern does. Chronic exercise results in a demand for high carbohydrate intake, since liver and muscle glycogen stores are frequently depleted by long duration, medium-to-difficult intensity workouts with insufficient rest periods between.

This creates a vicious cycle of overly stressful training that mostly burns carbohydrates; a diet of predominantly carbohydrates (by both strategic choice and from cravings to

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replenish from a depleted state); possible excess body fat despite a rigorous training regimen (because the athlete is inefficient at burning fat; because the athlete consumes too many calories in response to a chronic, stressful, and depleting exercise pattern; and because the athlete produces too much insulin, which compromises the ability to routinely burn fat at rest); a state of chronic inflammation (from both chronic exercise, the overconsumption of carbohydrates, and the overproduction of insulin); and an overstress/burnout condition (from abusing the fight-or-flight response via a chronic workout pattern and a chronic fluctuation of blood glucose levels that promote gluconeogenesis).

Caloric Efficiency:
Eating primally enables one to become less reliant upon external fuel sources for energy. This means that overall caloric intake can decline as you efficiently process internal fuel sources such as stored body fat, stored muscle and liver glycogen, ketones, and glucose made through gluconeogenesis. Being able to survive, and indeed thrive, on fewer calories not only predicts successful weight management, but also strongly correlates with longevity.

Improved caloric efficiency (aka metabolic efficiency) slows the rate of cell division, enhances cellular repair, optimizes the flow of adaptive hormones such as testosterone and human growth hormone in the bloodstream, and improves immune function. These are believed to be examples of evolutionary adaptation to selection pressure. When calories are not abundant, which has been the case for 99.6% of the 2.5 million years of human evolution, the body has to be more careful and more efficient at storing and dispensing energy and recovering from stress.

In contrast, excess calorie consumption over a lifetime speeds cell growth and cell division (cells are constantly burning ingested fuel, causing them to grow and divide). As discussed in Module 2 (regarding the Hayflick limit), accelerated cell division means reduced life span. Hence, those interested in longevity might want to reconsider the often-discussed goal of developing a "faster metabolism" in the name of body fat reduction, in favor of pursuing caloric efficiency. In the latter case, lifelong weight management is achieved naturally through the regulation of hormone function and appetite, and longevity benefits are realized as cells repair more efficiently and divide more slowly.
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The concept of becoming more calorically/metabolically efficient refutes the conventional wisdom notion that speeding up metabolism is a healthy and reasonable goal of eating and exercising diligently. Rather, the goal should be to become more adept at fuel partitioning (choosing stored body fat and internally manufactured ketones as the primary energy sources, rather than ingested calories; and furthermore, being able to efficiently burn a variety of fuels, including the occasional big hit of ingested carbs, for example), and being able to work, play, recover, and enjoy life on as few calories as necessary to achieve total dietary satisfaction, as well as to perform and recover well in one's daily endeavors.

At first glance, few may be excited by the recommendation to get by on fewer calories, as abundant caloric intake is commonly associated with pleasure and indulgence. Witness how devoted endurance athletes laud their ability to eat "whatever they want" without the adverse consequence of excess body fat. However, transitioning from conventional wisdom's "gas tank" mentality, a perspective that views regular meals and snacks as essential for energy, recovery, and sustainment of an accelerated metabolic rate, to an emphasis on food as a source of pleasure can be a liberating feeling. In the latter example, stored energy is always available, and blood glucose is effortlessly regulated. This enables eating patterns to become inconsistent, intuitive, and spontaneous. The driving factors for food and meal choices transition away from what time of day it is or the need to balance the blood glucose levels through external means, into eating patterns that provide the most pleasure and satisfaction, and gratify true sensations of hunger.

Mitochondria:

The cellular "power plants," mitochondria are responsible for producing energy inside cells in the form of ATP (adenosine triphosphate). ATP is a continually resupplied intracellular fuel source that is in high demand by the body and is a central element of the Krebs Cycle, aka the Citric Acid Cycle or the Tricarboxylic (TCA) Cycle. One of the fundamental principles of science, the Krebs Cycle is a series of chemical reactions that occur in all oxygen-breathing organisms as a way to generate energy through the oxidation of ingested fuel. Consequently, we have evolved numerous ways to manufacture ATP from the raw material of fatty acids, glucose, and ketone bodies. Production of ATP is a critical component of the Krebs Cycle.
Mitochondria require oxygen to produce their energy, and thus play a central role in fat metabolism in the body, since fat requires oxygen in order to be metabolized. The amount of mitochondria increase when you become fat-adapted, increasing the efficiency of oxygen processing throughout the body. In contrast, glucose metabolism can occur with (aerobically) or without (anaerobically) oxygen. The exceptions are red blood cells, which lack mitochondria and thus must metabolize glucose anaerobically. When glucose metabolism occurs anaerobically, the by-product is lactic acid, the cause of the familiar "burn" in the muscles associated with strenuous exercise. In addition to their power plant role, mitochondria are responsible for a variety of other functions relating to cell growth, cell death, and respiration.

**Mitochondrial biogenesis:**

Mitochondrial biogenesis is the process by which new mitochondria is created in response to dietary or exercise signals. Low carb, high fat, moderate protein eating will signal genes to become more efficient with existing mitochondria and to manufacture additional mitochondria. Intermittent Fasting is particularly stimulatory to mitochondria, since fasting forces the body to become more metabolically efficient when caloric energy is scarce. Both aerobic exercise and anaerobic exercise promote mitochondrial biogenesis.
Recommended Macronutrient Intake Levels:

The Spartan Method recommends a highly varied diet based mainly on personal preference within the guidelines of the Spartan Method Food Pyramid above.

- Animal foods (meat, fish, fowl, and eggs) comprise the bulk of dietary calories.
- Vegetables are recommended in abundance, comprising the bulk of emphasis on your plate.
- Healthy fats (macadamia nuts, coconut products, avocado, olives/olive oil) are another featured category.
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- Moderation categories include other nuts, seeds, and nut butters, seasonal fruits, high-fat dairy products, and supplemental carbs in the form of starchy tubers, quinoa, and wild rice for high-calorie burners.

Following the primal eating strategy should default you into an optimal intake of protein, carbohydrates, and fat to support health, peak performance, longevity, and effortless maintenance of ideal body composition. This includes plenty of room for daily and seasonal variation of macronutrient and total caloric intake.

**Protein:**

Start your macronutrient intake calculations with protein requirements, since adequate protein intake is critical for healthy metabolic function and the preservation of lean muscle mass. The Spartan Method recommends obtaining an average daily intake of around .5 grams of protein per pound of lean body mass. Dr. Ron Rosedale, a leading voice in the concerns about excess protein, suggests that .5 grams of protein per pound of lean mass is plenty for everyone. He believes that even high-protein-demand people (the highly active, growing teens, and pregnant women) need only to add 5-10 grams per day to that calculation to ensure optimal protein intake.

Lean body mass can be calculated by subtracting your fat weight from your total weight. You can multiply your body fat percentage (measured in a variety of ways) by your total bodyweight to determine your fat weight. For example, someone who weighs 150 pounds and has a reading of 10 percent body fat has 15 pounds of fat and 135 pounds of lean mass. Hence, they would calculate their protein requirement to be 135 pounds x .5 grams = 67.5 grams per day, perhaps 75 if highly active.

**Carbohydrate:**

Carbohydrate intake should align with the recommendations presented on the Primal Blueprint Carbohydrate Curve, which will be presented in detail in module 4. For lifelong health, weight management, and disease protection, no more than an average of 150 grams or less per day should be consumed. When grains, sugary foods and beverages, and other processed foods are eliminated from the diet, it's easy to default into this range. One hundred and fifty grams per day represents an abundant intake of vegetables, and a sensible intake of fresh, seasonal fruits, nuts, seeds, and even the sensible indulgence of dark chocolate. Those wishing to reduce excess body fat should limit carbohydrate intake to 100 grams per day or less in order to stimulate the burning
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of excess body fat for energy. This average can be easily achieved through Intermittent Fasting, strict attention to avoiding grains and sugars, and a reduced intake of fruits and starchy vegetables (sweet potatoes, etc.) during weight loss efforts.

Fat:
With recommended protein and carbohydrate intake falling into relatively narrow ranges, it follows that fat becomes the predominant macronutrient in the diet and the main variable in obtaining dietary satisfaction. Recommended fat intake is generally not an absolute number but instead should align with obtaining dietary satisfaction at every meal. Although high-fat foods are calorically dense, they have a high satiety factor and do not stimulate an insulin response. By eating what amounts to a high-fat diet in comparison to the SAD, one can stabilize appetite and energy levels, and shed excess body fat without having to face the traditional struggles of deprivation and restriction.

Review
Fat was the preferred fuel for humans throughout evolution, with most energy coming from either stored fat or ingested fat. Today we have overridden our genetic preference for fat by consuming a diet high in carbohydrates. Modern grain-based, high-carb diets stimulate excess insulin production, leading to a host of health problems often characterized as Metabolic Syndrome. Eating high-carb meals creates a blood sugar-insulin-burnout roller coaster that results in a dependency on dietary carbohydrates, along with an inability to reduce excess body fat despite careful attention to portion control and devoted exercise.

Weight management is about hormone optimization becoming a fat-burning beast instead of a carbohydrate addict. In the latter case, you have abundant energy stored in the glycogen and fat cells throughout the body but this energy is inaccessible thanks to chronically elevated insulin. At the same time, you experience frequent hunger because the bloodstream is devoid of energy.

We do have baseline requirements for glucose, but these can easily be obtained by eating nutritious plant foods and optimizing alternative sources of energy production in the body, such as the burning of ketones and fat. Even gluconeogenesis can be utilized as a way to top off glucose requirements, rather than the usual occurrence of
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gluconeogenesis stripping lean muscle tissue into glucose on an emergency basis as a fight-or-flight response to low blood sugar.

All ingested carbs are converted into glucose in the bloodstream, and the excess not immediately burned or stored as glycogen has the capacity to inflict damage throughout the body by binding to protein cells in a process known as glycation and the generation of Advanced Glycation End Products. Wrinkled skin, hardened arteries, and minor health conditions such as arthritis are driven or exacerbated by the process of glycation that is strongly associated with proinflammatory, high-carbohydrate eating patterns.

While fat is the centerpiece of the Spartan Method eating style, certain fats in the modern diet cause health problems, while others provide health benefits. Contrary to conventional wisdom, saturated fats are an excellent source of energy and nutrition with no adverse health effects. Chemically altered fats such as trans and partially hydrogenated fats and high polyunsaturated vegetable seed oils create oxidative damage at the cellular level and stimulate an inflammatory response upon ingestion, making them literally toxic agents that should never be consumed.

The omega-6:omega-3 ratio has been a bit miscommunicated to make omega-6 "bad" and pro-inflammatory and omega-3 "good" and anti-inflammatory. Both oils offer health benefits when obtained from healthy food sources. The big picture goal here would be to add more omega-3 fats (primarily from oily, coldwater fish) and minimize intake of the unhealthy processed foods that happen to be high in omega-6, such as industrial oils and processed grain foods.

Ketones are an energy-rich by-product produced in the liver when glucose levels are really low from a sustained pattern of low carbohydrate intake. Ketones are burned in a similar manner to glucose in the brain, and cardiac and skeletal muscle. Relying on ketone burning from time to time, either thru Intermittent Fasting or devoted carbohydrate restriction during short-term efforts to reduce excess body fat, offers an assortment of health benefits, including a potent anti-inflammatory effect.

Caloric efficiency can extend longevity by improving cell repair and slowing the rate of cell division, which is the essence of the aging process. The goal of becoming calorically efficient by training your body to burn fat as the preferred fuel refutes the
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notion that "speeding metabolism" (through devoted exercise efforts and meal timing) is the ideal method of maintaining ideal body composition.

*Mitochondria* are the power plants inside your cells that produce energy. A blend of comfortably paced aerobic exercise and regular brief, high-intensity strength and sprint workouts help enhance the function of mitochondria as well as stimulate the production of additional mitochondria. This helps you withstand the oxidative damage caused by all sorts of stressors in hectic modern life.

The Spartan Method recommended macronutrient intake levels are as follows:

- *Protein*, the first priority, should be consumed at a rate of .5 grams per pound of lean body mass per day on average.
- *Carbohydrates* should be limited to 150 or less, with some allowances for increased intake for high calorie burners who already maintain ideal body composition, or going below 100 grams per day in the interest of reducing excess body fat.
- *Fat* would then become the main macronutrient variable, with intake regulated by the goal of being totally satisfied at each meal and, of course, progressing toward the achievement and maintenance of ideal body composition.
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