



Introduction to Ketosis

Part 2

"An ounce of prevention is worth a pound of cure."

-Benjamin Franklin

Unless you have a metabolic condition (such as epilepsy) that requires a constant state of ketosis for disease management, the majority of us are striving to be in ketosis for the simple goal of becoming "fat - adapted." Fat-adapted means that your body is adapted to burn more fat for energy. Once fat-adapted, you will:

- stay full between meals
- have less or no sugar/carb cravings
- experience deeper sleep
- have more mental clarity
- burn body fat for energy, which can create an ideal body composition
- experience improved athletic performance by obtaining more energy from fat and conserving limited glycogen stores for when you really need them

Ketosis and “fat-adaptation” are similar concepts, but they are not the same thing. You can be fat-adapted, but not be in ketosis. It is an important distinction because getting and staying in ketosis for some people can be challenging. Nutritional ketosis requires strict carbohydrate restriction for a period of time, and for some people, this not a realistic life-long “diet.” If this is your situation, there is hope. Nutritional ketosis is one tool you can use to help your body become more fat-adapted. Once this state is achieved, you do not lose your fat-adaptation over night. After you are fat-adapted, you have changed your cells, mitochondria and liver to efficiently burn fat. One night of eating pizza might kick you out of ketosis, but it isn’t going to make you “not fat-adapted”.

Let’s remember that most of us have been running off glucose for most of our lives. Making the necessary changes on a cellular level to achieve all the benefits of being fat-adapted is not going to happen over night. It takes time (approximately 4-8 weeks when using nutritional ketosis to become fat-adapted). Ketosis is one tool you can use to help jump start your journey to becoming a fat burning machine (fasting is another way, but it is not nearly as fun as eating nutrient rich foods that are high in good, healthy fats).

There is hope for all of you carb lovers out there. You may get to eat pizza again (occasionally).

KETO-ADAPTION

After 3-7 days of carbohydrate restriction, your body will begin to produce ketone bodies (the time it takes depends on your metabolism, activity level, lifestyle and carbohydrate intake). There are two main ways to start producing ketones:

- Restrict carbohydrate intake to less than 5-10% of your bodies required caloric intake per day (this assumes you are not over consuming calories). For most people, this means less than 50g of net carbs per day.
- Fast for 24 hours or more.

In the early stages of ketone production, your body can produce a high amount of ketones which will build up in your blood stream. They build up because your liver has made them, but your tissues don't know how to use them (yet). After a period of time (usually a few days), you will see your blood ketone levels begin to drop. This is because your body has learned how to use these ketones as energy and they are now being utilized by your tissues. This rise and then fall of blood ketones can be incredibly frustrating to those who are using a blood ketone meter to measure ketone levels. But don't fret, this is actually an exciting thing. It means your body is becoming fat-adapted!

Once you know how, it is fairly easy to get into a state of ketosis. Unfortunately, in the early stages of adaption, it is also equally easy to be kicked out. Ketosis is a transient state and the earlier you are in the adaptation process, the easier it is to flow in and out of ketosis. In the long run, the key to becoming an efficient fat-burner as quickly as possible is to maximize the time you are in ketosis, and minimize the time you are out of ketosis. Once your body has made adjustments on a cellular level to be more efficient at burning fat for energy, the more flexibility you will have in your lifestyle and diet and still produce ketones.

HOW TO GET INTO KETOSIS (& STAY THERE)

REDUCE CARBOHYDRATE CONSUMPTION

Nearly every action required by your body to produce ketones in the liver are shunted by high insulin levels. Insulin is the storage hormone released by the pancreas in response to starches and sugars. The higher the starches and/or sugars are in a meal, the more insulin is released, and the lower your ketone levels will fall. In order to keep ketone levels high, you need to keep insulin levels low. This means all meals needs to be low in carbohydrates and sugars to prevent a spike in insulin levels.

INCREASE HEALTHY FAT CONSUMPTION

Ketone bodies are produced in the liver as a by-product of burning fat. In the early stages of keto-adaptation, when your body is unable to efficiently burn your stored body fat as energy, your liver can use exogenous fat from your diet to produce ketone bodies. Aim to consume 70-80% of your total calories from quality fats, such as: avocados, olives, coconuts, grass-fed animal fat, nuts and seeds.

TRACK (MACROS, GLUCOSE AND KETONES)

The strategy of monitoring is one of Gretchen Rubin's four "Pillars of Habits, " (along with the strategies of foundation, scheduling, and accountability). Accurate and effective monitoring helps you stick to your goals and keeps you honest with yourself. We have all had times where we thought we were doing something one way (like eating enough protein), only to find out after tracking that is was not the way we thought. Lucky for us, there are affordable ways to measure macronutrient consumption, glucose and ketone levels. Using a free

*You cannot manage what
you cannot measure.*

-Peter Drucker

online tracker, such as My Fitness Pal, can help you track your consumption of macronutrients.

Tracking your blood glucose (especially fasting in the morning) is an incredibly important marker of overall health. Since blood sugar dysregulation rarely comes with symptoms, it is something that can be out of optimal range without you ever knowing it. Optimal fasting blood glucose ranges should be between 80-99mg/dL. A fasting blood glucose reading between 100-199 mg/dL is an indication of blood sugar dysregulation and pre-diabetes. A fasting blood glucose reading over 200 mg/dL is an indication of type 2 diabetes.

In the US, 14.3 percent of adults have type 2 diabetes and 38 percent of the population has prediabetes, totaling 52.3 percent. This means that, for the first time in history, more people have the disease than not¹.

In addition to fasting blood glucose tracking, tracking your ketone levels will help you understand if your diet and lifestyle are promoting the production of ketone bodies in your liver (remember, just because you are eating low carb/high fat DOES NOT mean you are in ketosis!). There are three forms of ketones our body can create: acetate, acetoacetate, and beta-hydroxybutyrate. There are also three methods available to track these different ketones in the body: breath, urine and blood.

Ketone Breath Test- the ketone breath meter is a device you can use at home to measure acetate. Acetate is produced by gas exchange in the lungs and has been found to correlate closely with levels of beta-hydroxybutyrate in the blood. The key advantage to breath testing is that the meter is a one time purchase and it is re-usable (unlike urine or blood test strips

which are one time use) which makes breath testing very affordable. Unfortunately, there is very little research done using breath ketone meters and they tend to be very inconsistent.

Urine Ketone Strips- urine test strips are measuring acetoacetate directly from your urine. This method of testing is incredibly affordable and easy. However, it is only partially reliable in the early stages of keto-adaptation. As your liver begins to produce ketones, they will not all be used up by your tissues. It takes time for your body tissue to learn to uptake ketone bodies and use them as energy. During this time of adaptation when your liver is making ketones, but your tissue doesn't quite know how to use them yet, your body will need to get rid of them. To do this, they shuttle the unused ketones to your kidneys to be excreted through your urine. Once your body tissues learn how to uptake ketones more efficiently and use them as energy, this dumping of acetoacetate in the urine stops. This can lead people to think they are no longer in ketosis. In actuality, their body has become more efficient and is in a deeper state of ketosis.

Additional concern with the accuracy of urine test strips come from hydration status, which affect the acetoacetate concentration in your urine. Dehydration can cause a false high reading of ketosis.

Blood Ketone Testing- this form of testing measures beta-hydroxybutyrate and is the most direct and accurate way to measure ketone levels. The down side to this type of testing is the cost (you have to purchase a specific ketone meter, and the test strips can range in cost from \$.99/strip to \$8/strip). Oh, and you have to prick your finger (let face it, no one *likes* needles). The plus side is that this form of testing is extremely accurate.

Blood ketone readings above 0.5mmol/dL indicates a state of ketosis.

Now that you have these numbers, how do you interpret them. When read independently of other factors, these numbers will give you a general idea where you are in that exact moment. But we all know that our body parts don't work independently from one another and seeing how all of these work together to create a pattern will give us a more accurate picture of overall health.

Glucose Ketone Index (GKI)

The glucose ketone index is a formula that tracks the ratio of blood glucose and ketones in a single value. It is a tool for tracking your metabolic health and your level of ketosis.

[Fasted Glucose Reading ÷ 18] ÷ Ketone Reading = GKI

GKI	What it means	Application
≤1	You are in the highest therapeutic level of ketosis	Difficult to achieve without doctor's supervision
1-3	You are in a high therapeutic level of ketosis	Ideal for therapeutic treatment of disease such as Alzheimers, TBI, epilepsy, and cancer
3-6	You are in a moderate level of ketosis	Ideal for those with type 2 diabetes and obesity, insulin resistance, metabolic or endocrine disorders
6-9	You are in a low level of ketosis	Ideal for weight loss and health maintenance
≥9	You are not in ketosis	N/A

CONSUME MCT OIL

MCT oil is a food grade supplement that helps your body produce ketones. “MCT” stands for Medium Chain Triglyceride, which is a type of fatty acid found in foods such as coconuts. Unlike other fatty acids (such as long chain fatty acids), MCTs do not require bile or digestive enzymes to be broken down. They can be taken directly to the liver where they are converted into free fatty acids or ketone bodies.

FAST

Carbohydrate restriction is one way to produce ketones. Fasting is another. Fasting is willingly abstaining from caloric foods and beverages for a given period of time. When you fast, blood glucose (and therefore blood insulin) levels drop. This stimulates the release of fat-burning hormones, such as glucagon and adrenaline. These hormones will stimulate the release of fatty-acids from adiposites into the blood stream where they are carried to the liver to be made into ketone bodies. There are many methods of fasting that can be utilized to help kick start ketone production. The most utilized method is intermittent fasting, which typically restricts caloric consumption to a 6-10 hour window, with nothing but non-caloric beverages in the 14-18 hour window between. Some of the benefits of fasting include:

- a rise in human growth hormone which preserves lean body mass
- a steep drop in insulin which aids in preventing insulin resistance
- a rise in norepinephrine which keeps your resting metabolic rate high

Other popular fasting method include: alternate day fasting, Eat-Stop-Eat, the 5:2 diet, fat fasting, and

extended fasting. More on fasting in upcoming modules!

QUIT SNACKING

Many people have been taught that small meals consumed frequently thought the day will “rev-up” your metabolism. The truth is quite the opposite. Every time you put calories into your mouth (you don’t even have to swallow!!!), your body will release the hormone insulin. Insulin is a storage hormone that is released from the pancreas in preparation of glucose storage. When you consume small amounts of food every few hours, you keep a steady flow of insulin in your blood stream. This promotes fat storage and can create insulin resistance over time. If you are one who loves to snack, here are a few tips-

Balance your meals- eating a meal that is full of quality fats, protein and carbohydrates in the form of fiber rich vegetables will help to stay full longer.

Eat enough during meals- If you simply do not eat enough food at meal time, you will not have enough energy to sustain you until your next meal. Eat to your activity level. When you are highly active, you may need to eat more than on a day when you are more sedentary.

Replace the habit- many times we eat out of boredom, exhaustion and just plain habit. Before you eat, ask yourself “Am I *really* hungry?” If you aren’t sure, try drinking water, going for a walk or doing a few air squats. Usually these activities will stop the hunger sensation and allow you to get to your next meal without the need to snack.

Turn your snack into a meal- If you find that you are truly are hungry, eat an entire meal and try to avoid grazing as much as possible.

AVOID NON-CALORIC SWEETENERS

Have you ever heard of Pavlov's dogs experiment? Pavlov was a scientist who showed the theory of classical conditioning through his infamous dog experiment. He presented a stimulus (e.g. the sound of a metronome) and then gave the dog food; after a few repetitions, the dogs started to salivate in response to the stimulus. We humans are also subject to classical conditioning. When you place something sweet into your mouth, your brain receives a signal that something sweet is on the way. In response, the brain can send a signal to the pancreas to release insulin to prepare for the sweet thing to enter the blood stream. But nothing arrives. And you repeat this action again. And again. And again.

You can see how if you constantly chew sugar-free gum, drink non-caloric sweetened drinks or eat "keto-treats" that are full of sugar alcohols (or other non-caloric sweeteners), that your pancreas can quickly become incapable of keeping up with the insulin demands, and the cells of the liver and muscles can become immune to the signals of insulin. This is especially important for those that have a level of insulin resistance already. Limiting and/or avoiding non-caloric sweeteners all together can help your body be sensitive to insulin, which is what you want for longevity!

WORKOUT

The muscles are one of two locations that we store glucose in the body (the liver is the other). The muscles are also the largest consumer of glucose in the body, so the more you use your muscles, the faster the stored glucose will be used up. Once glucose stores in the liver and muscles are depleted, if exogenous glucose is not made available, the body will start to break down fatty acids for energy. Studies show that exercising

depletes liver and muscle glycogen faster than fasting?. On the flip side, too much exercise can cause a negative stress response (a chronic release of cortisol) and halt ketone production. Which leads us to the next point...

REDUCE STRESS

Cortisol is the hormone responsible for helping our body handle stress. It is released from our adrenal glands in response to anything our brain perceives as a threat. This can be a mean comment a coworker said to you, a food you consume that your body doesn't agree with, exercise (yes, this is a fight or flight activity), mold growing in your home, an action packed television show, driving, and, ugh...the list goes on and on. When our brain perceives a threat, it sends a signal to the adrenal glands to release cortisol. One of the many jobs of cortisol is to release sugar from the liver (so you can fight or flee). As sugar levels rise, insulin is released, and ketone levels fall. All without you ever putting anything sweet in your mouth. Bummer.

You are never going to escape all stressors in your life, but if you want to become an efficient fat burner, you will have to work hard to minimize your brain's day-to-day stress response. You can do this by adopting a meditation practice, deep breathing, more regular walks in nature, essential oils (lavender, bergamont, chamomile and rose are all known to help lower stress levels), drink tea that contains holy basil, eliminate foods that your body is sensitive to, reduce your toxic load (see module 2 on liver detoxification to help with this), and get more sleep!

PRIORITIZE SLEEP

Although you may think you can run on five or six hours of sleep, the short- and long-term effects of chronic

sleep deprivation are well studied and they are NOT good for your waist line, your overall health, OR for staying in ketosis! Some of the most well documented sleep studies have found the most profound effects on two powerful hormones: leptin and ghrelin. Leptin is the hormone responsible for telling us “you are FULL! Put the fork down!” and gherlin is the opposite, sending us signals of hunger and telling us to eat. In one study, subjects had an 18% lower leptin (satiation) hormone level and a 28% higher gherlin (hunger) hormone level after just two consecutive nights with less than 4 hours of sleep compared to a group who got 10 hours of sleep³. The subjects also reported higher rates of hunger for energy-dense, high carbohydrate foods.

Not only are sleep deprived people more prone to eating larger quantities of high carbohydrate foods when they are awake, they are also less likely to exercise, have higher levels of cortisol, and a higher rate of burning lean mass (instead of fat). All things that can shunt the body from producing ketones.

Just like blood sugar, movement and stress, we will spend an entire module on the details of sleep, but for now, here are some simple steps you can take to help you get enough zzz's:

Establish a SET bedtime routine- all humans (children and adults alike) respond better to routine, especially at night. Use the strategy of scheduling to put together a bedtime routine (which should start 4 hours before you actually lay down in bed) that you can follow every day.

Stop caffeine intake before noon- caffeine is a stimulant. It blocks adenosine, it suppresses melatonin and it increases dopamine, all neurotransmitters that can affect your circadian rhythm.

Caffeine also has an incredibly long half life (6-8 hours). Which means if you consume 16 ounces of coffee (300mg of caffeine) at 10am, you will still have 150mg of caffeine in your system around 6pm. And don't forget that coffee is not the only thing with caffeine. Just 1.5 ounces of 80% dark chocolate can have 40-75mg of caffeine. That means that your sweet craving you might be having after dinner should be satisfied with something other than dark chocolate!

Consume your last meal at least 3 hours before bedtime- YES, this is helpful for liver detoxification AND for getting restful sleep. Your digestive system is intended to rest during sleep hours and when you consume calories too close to bedtime, it stimulates your digestive system and can disrupt your ability to stay asleep.

Exogenous Ketones

Exogenous (meaning *outside* of the body) ketones are supplemental ketones made to mimic the ketones produced by your own body (*endogenous*) when following a ketogenic diet or fasting. Exogenous ketones are made up of beta-hydroxybutyrate. Therefore, when consumed, your blood levels of beta-hydroxybutyrate (ketones) will also rise. This can provide all the same perks that come with high levels of natural ketone bodies, such as mental clarity, increased energy levels and curbed hunger. However, they will not help your body tap into your own fat store to create ketones. For this reason, exogenous ketones are best used sparingly while becoming keto-adapted. Simply consuming exogenous ketones will not replace the metabolic benefits of a ketogenic diet. Consider using exogenous ketones if you:

- need to be mentally sharp for something like an important presentation
- need a boost of energy for an important workout
- just need a general pick-me-up

HOMEWORK

Part 1: Boost your ketone levels

Back to habit building...

Pick one of the 10 pointers listed in this module that you feel can use some focus. Using Gretchen Rubin's habit changing check list, dedicate the next 2 weeks to focusing on making improvements in this one area. If you have a ketone and blood sugar meter, track your numbers daily and see how making improvements in this one area can affect your ketone, glucose and energy levels.

For example:

HABIT- Use the strategy of scheduling to create a bedtime routine starting at 5pm.

5pm- Put on blue light blocking glasses and begin to minimize screen time

6pm- End of eating window (no chocolate past 2pm)

8pm- All screens are off + 15-30 minutes of mobility

8:30pm- Read (a real book or magazine) in bed

9pm- Lights out

REFERENCES

1- Dr Jason Fung, *Obesity Code*

2- Ann Nutr Metab, 1987; 31(2): 126-32; Effects of glucose or fructose on glycogen repletion in muscle and liver after exercise or fasting.

3- Harmon, Katherine, Oct 24, 2012; Scientific American; How Slight Sleep Deprivation Could Add Extra Pounds