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Consequences of Low-Carb Diets

Analysis by Ashley Armstrong | April 02, 2024

STORY AT-A-GLANCE

- Keto diets can provide immediate symptom relief and rapid weight loss, but may worsen health in the long run due to the reliance on gluconeogenesis, a less optimal metabolic pathway for producing glucose internally
- Low-carb diets fail to improve metabolic flexibility, inducing physiological insulin resistance instead, as they do not address underlying issues with glucose metabolism. Essential body parts, including the brain, muscles during strength training, and various organs, require carbohydrates for optimal functioning, highlighting the inefficiency of forcing the body to produce its own glucose through gluconeogenesis
- Relying excessively on gluconeogenesis for glucose production is energetically costly and inefficient, requiring a significant energy investment for a relatively low energy return, and is stimulated by stress hormones, potentially leading to muscle loss over time
- Low-carb diets can hinder thyroid function by reducing the liver's ability to convert T4 into the active thyroid hormone T3, essential for regulating metabolism, due to a decrease in glucose availability for the liver
- Reintroducing carbohydrates in a balanced manner can improve metabolism and overall health, countering the negative effects of long-term low-carb dieting by enhancing the body's energy production and usage

A keto diet can provide almost instant relief for certain symptoms and sometimes can even lead to rapid weight loss. While many may experience short-term benefits, there

are long-term consequences of low-carb diets that can make your health worse than before you started.

This article will address just two concerns of making your body rely on gluconeogenesis (the backup pathway to make the body produce its own carbs internally when we do not consume enough dietarily). But first — addressing some common arguments for low-carb.

Temporary Symptom Suppression Versus True Healing

The removal of an entire food group (like carbs) can certainly improve symptoms. For example — maybe there was a carb source you were consuming that was really aggravating your gut. Removing gut triggers will always make us feel better!

But there is a big difference between temporary symptom suppression and true healing — as restriction always comes with long-term costs. Running on stress hormones (which can occur in low-carb diets) may feel good at first, but they will quickly leave your body even more depleted than when you started.

Eating low-carb does not improve metabolic flexibility. Removing carbs doesn't fix a damaged glucose metabolism — as being low-carb for a long period of time actually induces physiological insulin resistance.

> *"The reduction of glycemia seen in low-carb dieting is not a sign of increased insulin sensitivity, but simply a removal of the challenge"* - Mamounis, Ph.D.[1]

It's like skipping leg day since you don't have strong leg muscles. But you don't experience any pain since the leg muscles were not worked! If you don't use it, you lose it! (Don't worry — this can be fixed! But avoiding carbs isn't what fixes your glucose metabolism machinery — it just avoids the trigger).

Endogenous Glucose Production Is Not Optimal

Others may argue that carbs aren't even needed in the first place with statements along the lines of — "But the body can make all the carbs it needs! Carbs are a non-essential nutrient!" Yes, this is true. The body can make its own carbs since carbs are essential for survival. But is it optimal to force our body to do this? No!

A counter to this "our body can make all the carbs it needs" is that our body can also make fat inside of our body[2] if we don't consume any dietarily. Is this optimal? Of course not. Certain parts of our body require carbohydrates to function and cannot use fatty acids or ketones for energy. Some examples include:

Red blood cells	CNS cells
Reproductive organs	Kidney medulla
Tissues in the eye	Muscles during strength training
At least part of the brain (yes, ketones can fuel ~70% of its energy demand on a low-carb diet. Otherwise, 100% of the energy is made from glucose)	

Thus, it is essential that the body maintains a minimum blood glucose concentration to supply at least these cells with glucose. If we do not eat enough carbs, our body will make them inside of us because they are vital for our survival.

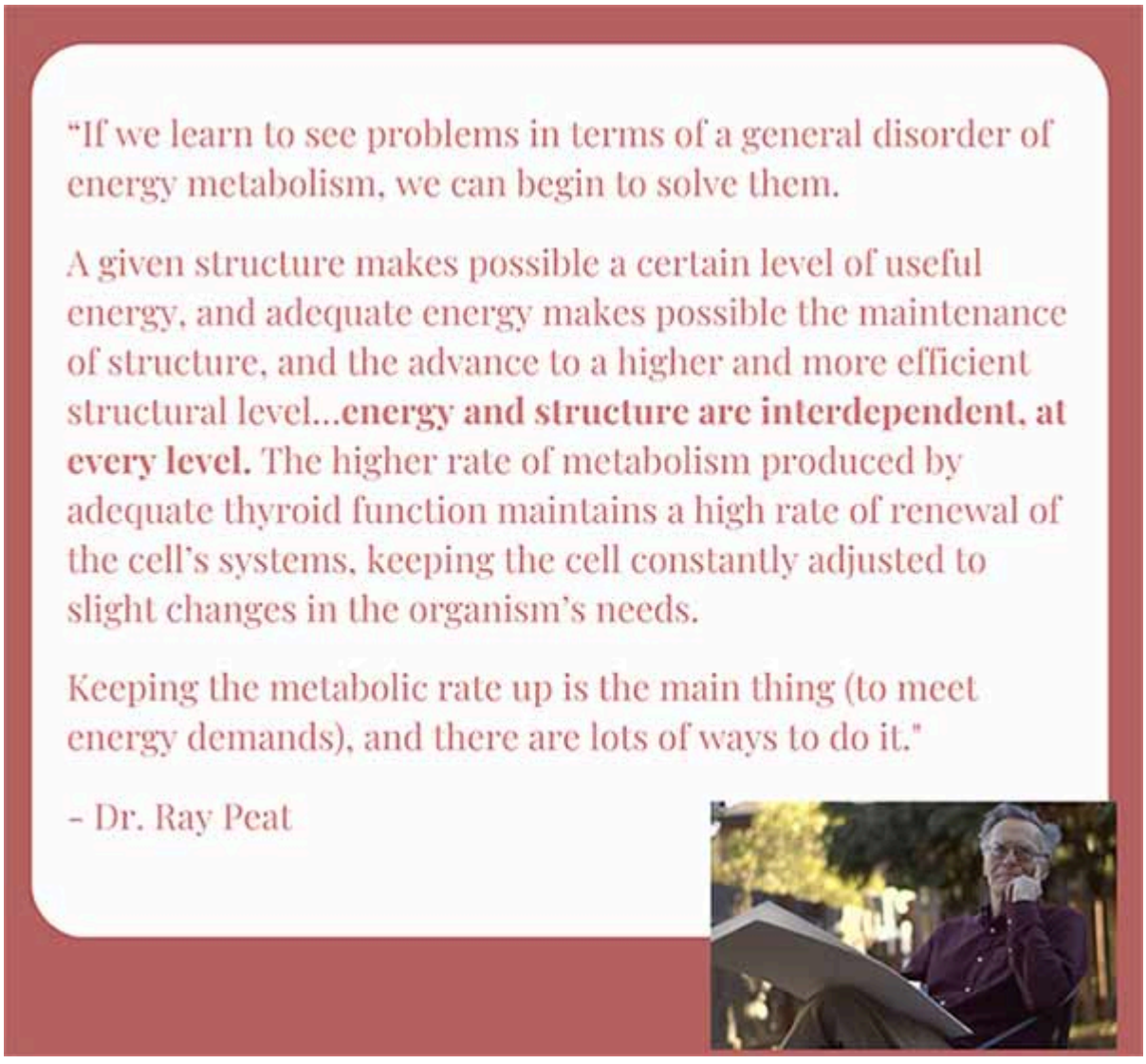
So, someone on a low-carb diet will thus rely more on a process called gluconeogenesis — a metabolic pathway that turns non-glucose substrates (dietary protein, dietary fat, and our own precious muscle tissue) into glucose.[3] There is always some level of gluconeogenesis happening in the background. But this process gets upregulated when restricting dietary carbs.

Long-Term Consequences of Low-Carb Dieting

Are there long-term consequences to rely on this pathway excessively? Long-term consequences to make our bodies generate carbs rather than consume them dietarily? I think so, yes.

Whether or not excessive gluconeogenesis is a good or bad thing depends on how you define health. Under the “pro metabolic” (aka bioenergetic) lens, a healthy body is really good at converting the food we eat into energy to maximize ATP (cellular energy) production.

A sign of a strong and robust metabolism is a high body temperature, as heat is generated as a byproduct of generating energy. The more energy (ATP) our body produces from the food we eat, the more functions our body can run. The more we will thrive, not just survive.



My personal “light bulb moment” that made me realize low-carb was not serving me well was when I first measured my body temperature — my temp was 96.5 degrees Fahrenheit! (Humans should reach 98.6 deg F mid-day) So my low body temperature was a clear sign that I was surviving in a low energy state, not thriving.

The less ATP our body has, the more “non-essential tasks” (like hair growth, a healthy libido, etc.) will need to be down regulated in order to prioritize the essential tasks to keep us alive.

> **“In a low energy state, the body conserves energy for survival. There isn’t extra energy to turn on non-essential tasks.”**

Characteristics of a Thriving Body

A thriving body will thus have the following characteristics:

High body temps (waking temps high 97s/low 98s - reaching 98.6 deg F. mid-day)	Daily poop(s)
Strong libido and hormone production	Good sleep
Strong hair and nails	High T3, low TSH and low rT3 (reverse T3)
Good energy	

If you have these things, GREAT! Don't change a thing! But many people on low-carb diets DO NOT and their thyroid hormone status is hindered. And this is not always due to the thyroid gland itself. The thyroid actually produces very little of the active thyroid hormones. It mainly produces the precursors.

The liver is responsible for producing most of the active thyroid hormone (T3) by converting T4 into T3. Cortisol, which can be chronically elevated on a low-carb diet, blocks that conversion.[4] And even without cortisol, not consuming many carbs leads to low T3 production[5] since T3 production is dependent on liver glucose and glycogen status.[6] In clinical studies a calorie restricted, low-carb diet depresses T3 levels similar to starvation, where a calorie restricted diet with carbs does not.[7]

And some low-carb advocates will argue that you don't need as much active thyroid hormone (T3). Well, low T3 will lead to low hypothyroid symptoms, regardless of the diet you're on. Thyroid health and the state of your metabolism go hand in hand since the thyroid is the master metabolism regulator.[8] Thyroid hormone T3 is inextricably related to cellular CO2 production and metabolic rate.[9]

Yes, our thyroid & body can function with lower T3, but I would argue that it is not optimal. There are SO many benefits to having more active thyroid hormone (T3).[10] The thyroid's hormones regulate vital bodily functions such as respiration, heart rate, muscle strength, body temperature, digestion, the conversion of beta-carotene to Vitamin A, and the conversion of cholesterol to downstream steroid hormones and protective hormones.

So, it makes sense why the liver would reduce T3 levels with a low-carb diet. Why would your body produce a hormone (T3) that increases your metabolism and makes you burn more energy when it doesn't have enough glucose coming in? Let's now dive into just two concerns about long-term reliance on excessive gluconeogenesis (required on low-carb diets).

Gluconeogenesis Is Inefficient and Requires a Lot of Energy

Overall, six ATP worth of energy is invested to produce one molecule of glucose, which gives us only two ATP when broken down through glycolysis. It's like trading $6 bills for $2 bills.

> *"One of the most pervasive themes in biology is the drive to conserve energy. That we will spend this much energy synthesizing glucose is a testament to how essential it is to our life and well being."* Chris Masterjohn, Ph.D.

This is expensive and not efficient, using up valuable energy reserves slowly over time — why would our body choose this pathway unless it absolutely needs to? And since gluconeogenesis largely occurs in the liver, why would we want to burden the liver even more when it already has over 500 functions and is busy detoxing for us?

Most people are in a low energy state to begin with — why dig ourselves into a deeper hole? Wouldn't we want to choose a path were more ATP is generated so that our bodies have the energy to perform more functions?

Gluconeogenesis Is Regulated by Stress Hormones

> *"Gluconeogenesis is stimulated by the diabetogenic hormones (glucagon, growth hormone, epinephrine, and cortisol)."*[11]

While there are some studies showing that fat adapted athletes do not have higher blood cortisol levels, we have to remember that tissue and blood levels of cortisol can be different,[12] and it is hard to easily measure tissue levels of cortisol.

> *"Since gluconeogenesis is an extremely expensive investment with a negative return, it makes sense that the body would regulate it as a stress response, and thus place it under control by cortisol." Chris Masterjohn, Ph.D.*

Elevated stress hormones will be very catabolic in the long run. Meaning, muscles can get wasted away slowly over time. I was certainly in denial at the time, but my lifting numbers (squat and deadlift weights) and muscle mass went DOWN while I went low/zero-carb for an extended period of time.

"But what about *insert muscular low-carb person*?" For these individuals you may idolize that eat zero-carb and strength train — you have to ask yourself, did those individuals build their muscle mass before switching to this no carb lifestyle? And are

they now just maintaining or very slowly losing muscle over time? Have you seen DEXA scans before and after their dietary switch?

Dr. Peter Attia (who used to be a proponent of keto and fasting), noticed for himself and a number of his patients who were strength training and consuming low-carb diets experience 'body recomposition gone wrong' (through DEXA scans).

Over time (over a few years), himself and his patients maintained their weight. But in the background, they were losing muscle tissue (due to excessive gluconeogenesis) and increasing fat mass. This is not what we want!

Can you gain muscle on a low-carb/zero-carb diet — sure! There are always exceptions! But why would you choose the harder path? (If this was a better way to build muscle, trust me, bodybuilders would be keto or zero-carb. But they aren't.)

This type of zero-carb muscle building approach is such a delicate balance of your fat and protein macros. You need to consume high fat to provide energy and get you into ketosis. But if you don't consume enough protein, your body will break down your muscle tissue at higher rates to get ahold of some amino acids. But too high of protein will kick you out of ketosis due to higher rates of gluconeogenesis. WHY NOT JUST GIVE THE BODY WHAT IT NEEDS? (Carbs)

Because many people are convinced that a low-carb state is somehow optimal and improves metabolic flexibility and is required to lose weight (not true). I get it — I was deep into that ideology! AND many people have damaged glucose metabolisms — so avoiding the use of the damaged machinery can feel good in the short-term.

So, avoiding the use of the "damaged machinery" can feel good in the short-term. But continuously restricting carbs is avoiding the use of a damaged glucose metabolism. It isn't fixing it. And there are tremendous health benefits to improving your glucose metabolism!

Of course, transitioning from a crappy standard American diet filled with processed food and PUFAs to a whole food, low/zero-carb approach will bring tremendous benefits. And

again, if you are doing well — don't change a thing!

How Can I Add Carbs Back In?

Always start slow! If you haven't consumed carbs in a long time and add them in abruptly, how can you expect your body to know what to do with them? Start with one source that you enjoy and digest well, and slowly increase the amount of it you consume over time.

As you slowly increase your carbs, it can help to slightly reduce fat consumption in parallel. The goal is to get to a place where you can consume carbs and moderate fat levels (more of a mixed diet), but that requires a well-functioning glucose metabolic machinery.

Tracking this data using an app like Cronometer can really help you move the needle forward with your health. In parallel, track your body temperature to see what foods (and amounts) are raising your body temperature (and metabolism) over time. This type of an experiment allows you to take a “metabolism focused” approach instead of a fear-based, restrictive approach.

Calories in vs. calories out still matters when it comes to fat loss phases and long-term health — but when you have a better metabolism, the calories OUT side of the equation increases — the body uses more of the food we consume to generate energy, instead of storing it as body fat. Meaning, you can eat more calories while maintaining (or even losing) weight, making weight maintenance a lot more sustainable.

My personal experience: After about 1.5 years of taking a low-carb approach, I finally “woke up” that I was driving myself into the ground. It felt good, until it didn’t. I became irritable, developed more and more food sensitivities, was losing hair, had no libido, lost strength and muscle mass and more.

Excessively relying on gluconeogenesis down regulated my metabolism and thyroid health over time. And under the “bioenergetic lens” — that is just surviving, not thriving. Short-term band-aid solution, not long-term, sustainable health. Making slow dietary

changes while monitoring my body temperature and pulse was key to helping me get out of a low-metabolic state. I now consume over 3,000 calories as a 135-pound woman!

In Summary

If we understand how our physiology works, why not give it what it needs? Gluconeogenesis is an inefficient and "expensive" process that uses up valuable energy when the process is unregulated. Not consuming carbs may "work" and provide digestive relief (relative to a diet filled with hard-to-digest carbs and high amounts of PUFAs).

But at what cost? What processes and functions will get down regulated to allow for this excessive gluconeogenesis? Sleep problems? Digestive issues? Hair loss? Hormonal problems? Low libido? Low energy? Skin issues?

If what you are doing now is working for you (high body temps, good sleep, good poops, strong libido and hormones, good skin and hair health, and are happy/treat people kindly) — don't change a thing. But if you are pushing a diet ideology that has led you on a hamster wheel of weight, binge, and health cycles — don't be afraid to step outside of your comfort zone and try something new.

> *"Think, perceive, act."* ~ Dr. Ray Peat

If you are looking for more assistance in improving your metabolism, adding carbs back into your diet without weight gain, and reversing out of a low-carb diet — my sister and I teach you how to do so in our in-depth course called **Rooted in Resilience**, along with a ton of free downloads and information on our website, **www.armstrongsisters.com**.

We have both been through all the diet fads and extremes out there — and all they did was lower our metabolisms in the long run. So, it is our goal to provide you with the educational tools so that you can have FOOD EDUCATION and EMPOWERMENT and not FOOD FEAR. Because understanding human physiology and energy metabolism helps YOU better cut through the noise of all the conflicting health information out there.

Learning about energy metabolism was one of the reasons we wanted to start a farm and be involved in food production. The types of fat you eat can hinder how you utilize carbs, as PUFAs (polyunsaturated fatty acids) hinder your ability to properly utilize carbs.[13] For example, PUFAs negatively inhibit cytochrome C oxidase activity,[14] a vital enzyme required for proper carb metabolism.

And when it comes to animal fats, what your food eats, matters, as the types of fat in poultry and pork products are impacted by the types of fat in their diet. So, if fed a diet rich in PUFAs, the amount of PUFAs in the eggs, chicken, and pork fat increases.

The Best Nutrition Course Is NOW Available for You!

I have very good news to announce. Very shortly I will be sending out invites to train individuals interested in becoming one of my health coaches. My health coaches will be some of the best trained coaches on the planet because they will understand how biology works and how to correct it to optimize health.

Many will apply but only a few will be accepted. Once they are accepted, they will be allowed to enroll in my nutritional biochemistry course at no charge. This course is based on the concepts of the late Dr. Ray Peat who popularized bioenergetic medicine. That's a fancy word for optimizing diet choices to maximize cellular energy production.

Poorly functioning mitochondria is pervasive and probably exists in 98% of the population. Diligent application of the principles outlined by Doctor Peat will help your mitochondria recover so they can produce the amount of energy they were designed to. This is important because your body needs energy to activate its intrinsic healing capacity.

The foundation for the nutritional biochemistry course that will be taught to our health coaches is from a course that Ashley put together. It took her more than one year to write this course, and in my view, it is the best health course I've ever seen in my life.

I only wish I had had this course when I first started practicing medicine. It would have been a game changer. It's hard to imagine how many additional hundreds of millions of

people I could have helped with this knowledge. Not to worry though as the knowledge is now available for you.

If you are seriously interested in understanding how your body works, and more importantly, what specific actions you can take to guide it to working the way it was designed to, then **this is the course you need to take**.

You can enroll for the course on her website. Please understand that I take no commissions from recommending this course. All the funds go directly to Ashley. She is probably the most knowledgeable farmer on the planet when it comes to health. This is why she can produce some of the healthiest food possible. But you may realize that farmers don't earn very much, so you can support her mission to provide the world with healthy food by **purchasing her course**.

I would encourage you to seriously consider taking advantage of the wealth of knowledge that has taken her many years to compile and make available to you in an easy to learn format.

Low PUFA Eggs and Bacon From Angel Acres Egg Co. and the Nourish Cooperative

The types of fat you eat can impact how you utilize carbs, as PUFAs can hinder proper carb utilization. And when it comes to animal fats, what your food eats, matters. (If their diet is high in PUFAs, the final product will contain more PUFAs). With the current agriculture system, knowing where your food comes from is vital. The article was written by Ashley Armstrong, who is passionate about providing the highest quality food possible.

Armstrong is the cofounder of Angel Acres Egg Co., which specializes in low-PUFA (polyunsaturated fat) eggs. We **discussed the importance of low-PUFA eggs in a recent interview**, embedded above for your convenience.

Angel Acres Egg Co. ships Low PUFA eggs to all 50 states — but there is currently a waiting list as she slowly increases the number of chickens within the network to fulfill the demand. More egg boxes will be available this spring — join the waitlist for low PUFA egg boxes here.

Armstrong also co-founded Nourish Cooperative which ships the best low PUFA pork, beef, cheese & A2 dairy and traditional sourdough to all 50 states. They are also close to accepting new members to the farm cooperative — join the waitlist here: nourishcooperative.com.

In the video segment above, Ashley reflects on the timeline of her decision to invest her free time into regenerative farming, considering how just a few years ago, her health was far from ideal. She struggled with mitochondrial energy production, and her body was in a low thyroid state. Your body prioritizes energy for essential tasks, and decision-making requires significant energy.

Your brain consumes about 20% of your body's energy despite being only 2% of its weight. Ashley simply would not have had enough cellular energy to supply her brain to make a decision like she did unless she improved her health. Factors like excess linoleic acid, estrogen and endotoxins were depleting her cellular energy, which is crucial for making energy-intensive decisions.

Her transformation underscores the power of nurturing your health to gain the energy necessary for making significant life changes. Avoiding dietary pitfalls like seed oils played a key role in this journey, enabling her to tap into a newfound capacity for brave decisions — a testament to the profound impact of regaining cellular energy on her ability to navigate life's choices.

It is my sincere desire and hope that you consider her journey to inspire and empower you to make similar choices in your own life and reclaim the Joy that you deserve. Imagine experiencing the nearly limitless Joy that Ashley has with her 1,000 chickens and four livestock guard dogs below.

Sources and References

- [1] Journal of Evolution and Health 2017; 2(1)
- [2] European Journal of Lipid Science and Technology June 6, 2006; 108(6): 521-525
- [3] Metabolism August 24, 2020; 64(4): 607-647
- [4] J Neurosurg Anesthesiology April 2004; 16(2):122-5
- [5, 6] J Clin Invest 1978 Aug; 62(2): 415–424
- [7] J Clin Endocrinol Metab 1976 Jan;42(1):197-200
- [8] Physiol Rev 2014 Apr; 94(2): 355–382
- [9] Journal of Evolution and Heatlh, The Dangers of Fat Metabolism and PUFA
- [10] Curr Nutr Rep 2019 Dec;8(4):402-410
- [11] Textbook of Veterinary Physiological Chemistry 2015, Gluconeogenesis
- [12] Steroids 2022 Jan:177:108947
- [13] Journal of Applied Physiology January 1, 2008; 104(1): 1-9
- [14] Journal of Hepatology November 2004; 41(5):721-9