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The Hidden Triggers of Insulin Resistance and How to Restore Balance

Analysis by Dr. Joseph Mercola | November 25, 2026

STORY AT-A-GLANCE

- When cells become insulin-resistant, they struggle to use glucose for energy, and more of the excess glucose may be shunted into fructose through the sorbitol pathway — a "backup route" that has been proposed to buffer an immediate crisis but that is linked to long-term damage
- Modern diets high in refined sugars and seed oils (like soybean and corn oil), combined with exposure to environmental toxins and plastics, are thought to help explain why more than 99% of Americans are estimated to have some degree of insulin resistance
- The HOMA-IR blood test provides an early warning for insulin resistance, with scores above 1.0 suggesting it may be time to look more closely at diet and lifestyle
- Contrary to popular belief, white rice may be healthier than brown rice for people with insulin resistance, as brown rice's fiber can feed harmful gut bacteria and its higher omega-6 content can promote inflammation
- Most adults need about 250 grams of carbohydrates daily. Severely restricting their consumption can trigger stress hormones like cortisol, which can break down muscle tissue to create glucose

Insulin resistance often starts without major warning. You could be eating candy bars or drinking sweet sodas every day and feel just fine — at least at first. However, behind the scenes, your cells are struggling to handle all that sugar.

You might have heard that sugar can give you an immediate rush, but once that rush wears off, the rest of the sugar puts your body under stress. Over time, as your mitochondria get clogged by harmful substances or overworked by all the sugar, they may not burn glucose efficiently. When your body experiences insulin resistance, it can't move glucose into cells very well.

Certain chemicals in our environment can also damage mitochondria, acting like "poisons" that weaken these crucial power plants. Once your cells are exposed to these mitochondrial poisons long enough, they may start to rely more on the sorbitol pathway, which turns glucose into fructose. One way to view this shift is as a stopgap that keeps blood sugar from climbing even higher — but heavy, sustained use of this pathway has been linked to tissue damage over time.[1,2]

If this process continues unchecked, it may contribute to bigger problems like Type 2 diabetes, heart disease, or severe liver issues — one reason many adults face health struggles later in life, despite feeling fine in their younger years.

Understanding the Role of Insulin

Insulin is a hormone that does one of the most essential jobs in your body: it helps manage how your cells take in and use sugar (glucose) for energy. If you think of sugar as tiny pieces of fuel, insulin acts like the fuel injector that delivers gasoline into a car's engine. Without it, the car cannot start. In your body, that means your cells don't get the energy they need from the sugars you eat.

- **Insulin is produced by special cells in your pancreas called beta cells —** Insulin moves through your bloodstream and attaches to receptors on each cell's surface. Once connected, it signals your cells to open channels so that glucose can enter and power all the chemical reactions that keep you alive.
- **When everything works well, insulin levels naturally rise after you eat a meal —** Your pancreas senses an increase in blood sugar from the foods you've just eaten — especially carbohydrates — and it responds by releasing insulin. This insulin quickly

ushers sugar out of the bloodstream and into your cells, preventing excessively high blood sugar levels.

- **At the same time, insulin keeps your body's energy production stable —** This allows you to think, play, learn, and do everything else without feeling tired. Even though insulin's work is done on a microscopic level, the effects are enormous. From clear thinking to physical movement, everything depends on your cells having the right amount of energy.

- **A big reason insulin matters so much is that it ties directly into how your body stores fat and uses muscle —** It even signals your brain about how hungry or full you feel. If your body needs more energy later, insulin also helps store some of that sugar in your liver or muscles as glycogen, a special form of stored sugar.

  At the right time — when you're active or during the hours after you've finished a meal — your body can easily tap into those stored reserves. This entire system is orchestrated by insulin, making it one of the key players in your overall health. Whether you're eating an apple or a bowl of ice cream, insulin's job is to ensure that what you eat translates into energy, helping your cells keep up with the demands of daily life.

Yet, as straightforward as insulin's job might seem, many factors can disrupt this careful balance. Things like the kinds of fats you eat, the added sugars you consume, and various environmental toxins can interfere with how insulin does its job.

Medication Lowers Blood Sugar, but It Doesn’t Repair Your Mitochondria

Medications and insulin injections lower blood sugar in different ways, and for many people they are an important — sometimes essential — part of care.[3] However, in the bioenergetic view, lowering blood sugar does not, by itself, address what may be a deeper problem: damaged or overloaded mitochondria.

- **It's like trying to pour more water into a clogged sink —** While the water might eventually drain, the blockage underneath remains, causing ongoing problems. Meanwhile, if you keep eating sugar and living in an environment with mitochondrial poisons, your cells keep struggling, and you rely more and more on blood sugar-lowering measures alone.

- **Lasting improvement may depend on cleaning up the mess inside the mitochondria —** If your environment stays filled with harmful substances, and your food remains high in sugar and unhealthy fats, the fundamental damage keeps piling on, even if medicine is holding your blood sugar at safer levels.

- **Using insulin or other medication can be lifesaving in some cases —** However, deeper metabolic issues remain unaddressed. In other words, you may see your blood sugar numbers go down, but the trouble inside your cells lingers.

If you take medication or insulin to manage your blood sugar, don't stop or change it on your own. Talk with your health care provider before making any changes, and use the strategies I outline in this article alongside — not in place of — their guidance.

How Metabolic Dysfunction Affects Daily Life

The story of insulin resistance is that of cause and effect. Eating lots of sugar and being around harmful chemicals make cells struggle to burn energy properly. Over time, your body may face more reductive stress, and more glucose may be diverted into fructose through the sorbitol pathway.

- **This detour may help keep blood sugar from climbing to extreme levels —** However, it has been linked to long-term damage such as fatty liver, nerve problems, and a higher chance of diseases like Type 2 diabetes. Kids see sugary foods everywhere — birthday parties, vending machines, and fast-food menus. It's no wonder so many people grow up never realizing the potential harm they're doing to their inner power plants.

- **Fortunately, knowing about this process early on gives you a big advantage —** You can make better decisions, like choosing water over sugary drinks and eating more fruits and vegetables at mealtimes.

The more you understand about how your body converts food to energy, the clearer it becomes that small daily choices add up. Instead of trusting flashy ads or quick fixes, you become someone who can recognize what truly helps your health and what might be setting you up for trouble years later.

When the Fuel Injector Stops Working — Defining Insulin Resistance

Insulin resistance happens when insulin can no longer easily get glucose into your cells. Another way to think about it is as a lock and key — if your lock becomes rusty or changes shape, even the perfect key might struggle to fit. In your body, that "rust" may come from a buildup of factors like too much processed sugar in your diet, exposure to toxins, harmful fats like those found in seed oils, plasticizing chemicals, and EMFs.

- **Over time, your cells become progressively less responsive to insulin's signals —** Your pancreas senses that glucose is not getting inside your cells and responds by making even more insulin, hoping a higher level of it might fix the problem.[4,5] At first, this extra insulin might succeed, but it rarely, if ever, addresses the root cause of the "rust" inside the lock.

- **This process doesn't happen overnight —** It can begin as early as childhood, especially with a diet that is high in processed sugars, or if there's too little exercise to help burn off the extra fuel. Insulin resistance often begins silently, with no obvious signs.[6] People might still have normal blood sugar levels for a while because the pancreas is working in overdrive.

- **However, this high-insulin state has been linked to weight gain, especially around the waist —** It may also contribute to mood swings and energy crashes after meals. Eventually, if your cells stay resistant for too long, the pancreas might become

exhausted, and that's when blood sugar starts to climb to unhealthy levels.

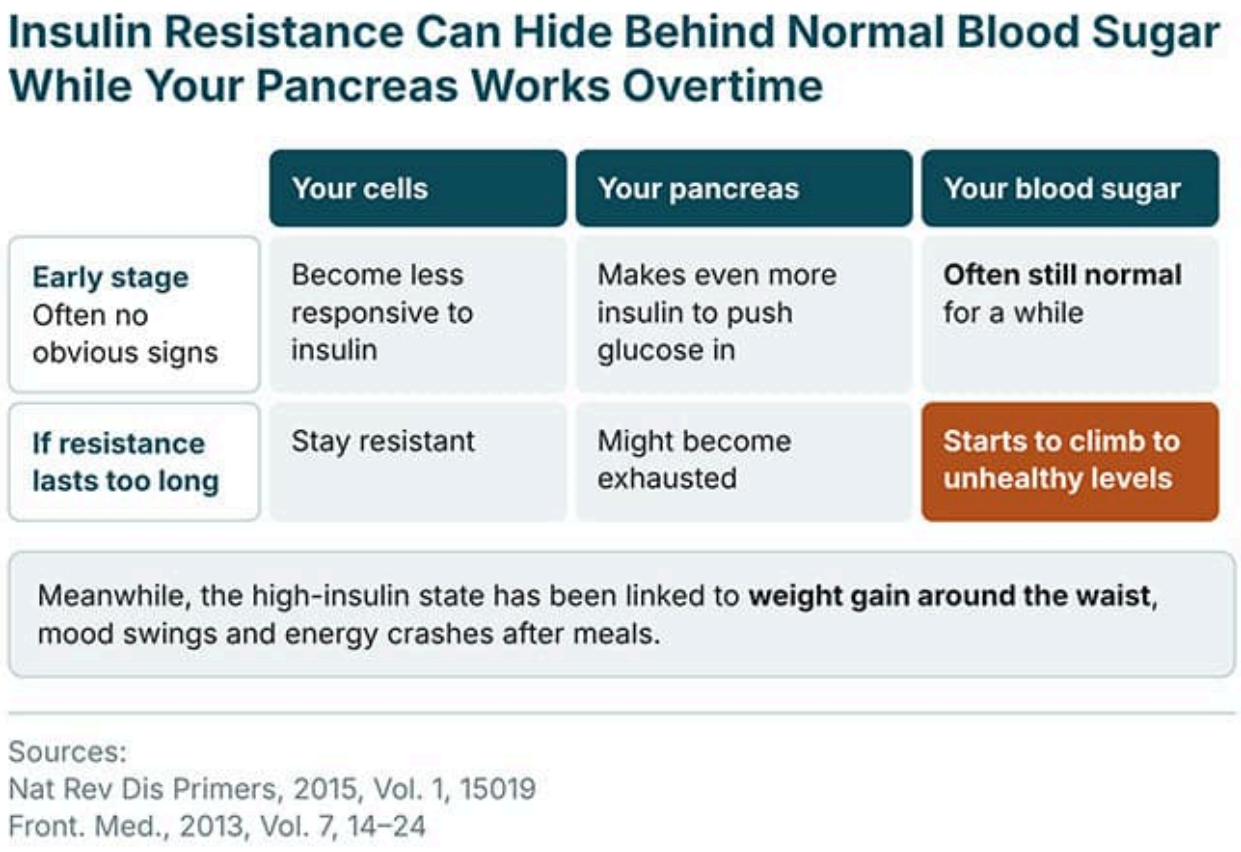

Figure 1. *As cells stop responding to insulin, the pancreas makes more of it and blood sugar can stay normal for a while, until the pancreas may tire and blood sugar starts to climb.*

Although it might sound complex, the core idea is this: your cells are pushing back against insulin, refusing to open their doors fully for glucose. This sets the stage for many troubles. Imagine if you consistently poured fuel onto a fire that just keeps smoldering without ever burning cleanly. Sooner or later, the buildup of partially burned fuel causes smoke and damage.

In your body, insulin resistance is that smoldering fire. It keeps adding strain on your organs, your metabolism, and your mitochondria, setting the stage for a chain reaction of health issues down the line.

Why Insulin Resistance Is So Alarmingly Common

It might surprise you to learn that more than 99% of people in the United States are estimated to have some level of insulin resistance. This does not mean everyone has a severe problem, but rather that most people are on a spectrum. Some might have a mild form, while others have a more advanced form that is associated with serious diseases. Why is it so widespread?

One major reason is the modern diet. In one analysis of household food purchases across 19 European countries, nations where ultraprocessed foods made up a larger share of the food supply tended to have higher rates of adult obesity — an ecological study that shows a population-level association, not individual cause and effect.[7]

- **The type of sugar you ingest matters —** There's a big difference between eating a piece of whole fruit, which has fiber and nutrients that help slow sugar absorption, and drinking a soda or eating candy packed with refined sugar.[8]

  The latter floods your bloodstream with glucose. Without fiber or other helpful nutrients, your blood sugar spikes quickly, forcing your pancreas to release a lot of insulin. Over time, these repeated surges in insulin may dull your cells' response to the hormone.[9]

- **Another key contributor is the type of fat you eat —** Seed oils like soybean and corn oil have become part of nearly every processed food. These oils degrade and oxidize easily, especially when heated, forming harmful byproducts that may harm your cells and impair their ability to respond to insulin.

- **These oils can also change the composition of your cell membranes —** This may further complicate how your insulin receptors work. Combine that with the fact that many people are exposed to environmental contaminants — like certain plastics that release chemical compounds — and to electromagnetic fields (EMFs) from electronic devices, and these exposures can add up to a significant metabolic burden.

- **Other factors that contribute to insulin resistance —** Additionally, modern lifestyles often include chronic stress, inadequate sleep, and not enough movement. All of these factors increase the likelihood of insulin resistance. Stress hormones, such as cortisol, make your cells less responsive to insulin when they remain high for too long. Poor sleep can also disrupt hormones that regulate hunger and blood sugar.

Meanwhile, a sedentary lifestyle means that the glucose in your bloodstream isn't used up by your muscles, so your pancreas has to keep pumping out more insulin. All these elements merge into a huge puzzle, with insulin resistance sitting right in the middle. Understanding this puzzle is essential for learning how to protect yourself from the long-term impacts of a metabolism that struggles to do its job efficiently.

Cortisol and the Importance of Eating Enough Healthy Carbohydrates

Many people today are drawn to low-carb diets because sugar is frequently seen as the main culprit behind health problems. While it's true that excessive amounts of refined sugars can lead to major issues, the idea that all carbohydrates are harmful is a big misunderstanding.

- **Your brain and body rely on a steady supply of glucose —** Most adults need about 250 grams of carbohydrates every day, and far more if they are very active. This isn't an optional requirement; it's absolutely essential for keeping your cells and organs functioning properly.

- **What happens when you deprive yourself of the carbohydrates you need?** Your body resorts to creating glucose in other ways. While this might sound like a handy trick at first, it often involves triggering the release of stress hormones such as cortisol, adrenaline, and glucagon.

- **The hormone that raises the biggest red flag is cortisol —** Cortisol, which spikes when you're emotionally stressed, also surges when your body senses it's not getting enough glucose from your meals. In either case, one of the hormone's

actions is the same: it can break down muscle tissue to harvest amino acids, which are then converted into glucose. This process keeps your blood sugar high enough to survive, but it sacrifices precious muscle mass in the process.

Over the long run, this muscle breakdown contributes to frailty and loss of strength, especially as you age. Think of it as your body's emergency measure. It's great in a pinch but problematic if it becomes a daily occurrence.

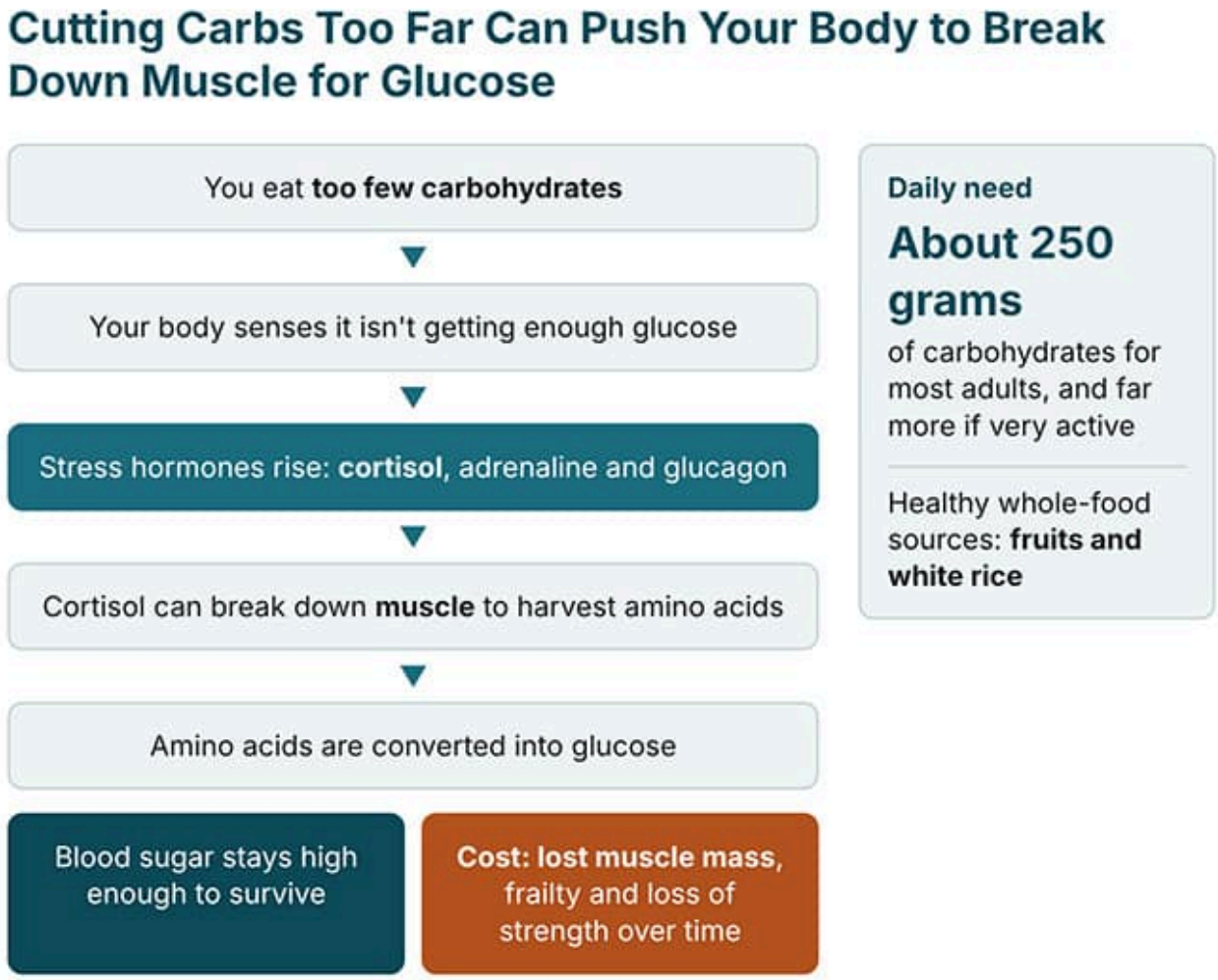

Figure 2. *Eating too few carbohydrates can trigger cortisol, which can break down muscle to make glucose; most adults need about 250 grams of carbohydrates a day.*

- **Chronically elevated cortisol can undermine metabolic health —** You might feel energetic at first when you drastically cut carbs, but beneath the surface, cortisol may be chipping away at the very tissues you need for mobility, balance, and

metabolic health.

That's why it's wise to include healthy, whole-food carbohydrates — like fruits and white rice — rather than eliminate them entirely. By doing so, you provide your system with the glucose it requires without forcing your body to tear down muscle.

Ultimately, the goal isn't to drown your body in sugar, but to avoid tipping it into a constant state of stress where cortisol runs wild. A balanced approach helps you maintain sufficient carbs to keep cortisol in check, protect your muscles, and preserve the resilience that supports a healthy, active life in the long term.

Using HOMA-IR to Spot Insulin Resistance Early

One of the simplest and most reliable ways to gauge how well your body handles insulin is through a test called HOMA-IR, short for Homeostatic Model Assessment of Insulin Resistance.

- **How to get your HOMA-IR score —** Unlike other cumbersome procedures, HOMA-IR only requires two basic blood tests done first thing in the morning before you eat: one for fasting glucose and one for fasting insulin levels. These tests are relatively affordable and widely available at most labs. Armed with those numbers, you then plug them into a straightforward formula to get your HOMA-IR score:

  HOMA-IR = (Fasting Glucose in mg/dL × Fasting Insulin in μU/mL) / 405

- **The goal is to see just how hard your body is working to keep your blood sugar in check —** If your HOMA-IR is higher than 1.0, it's generally a warning sign that you might be edging into insulin resistance territory. The lower your score, the better your insulin sensitivity, so even values that hover around 1.0 deserve some attention if you're looking to optimize your health.

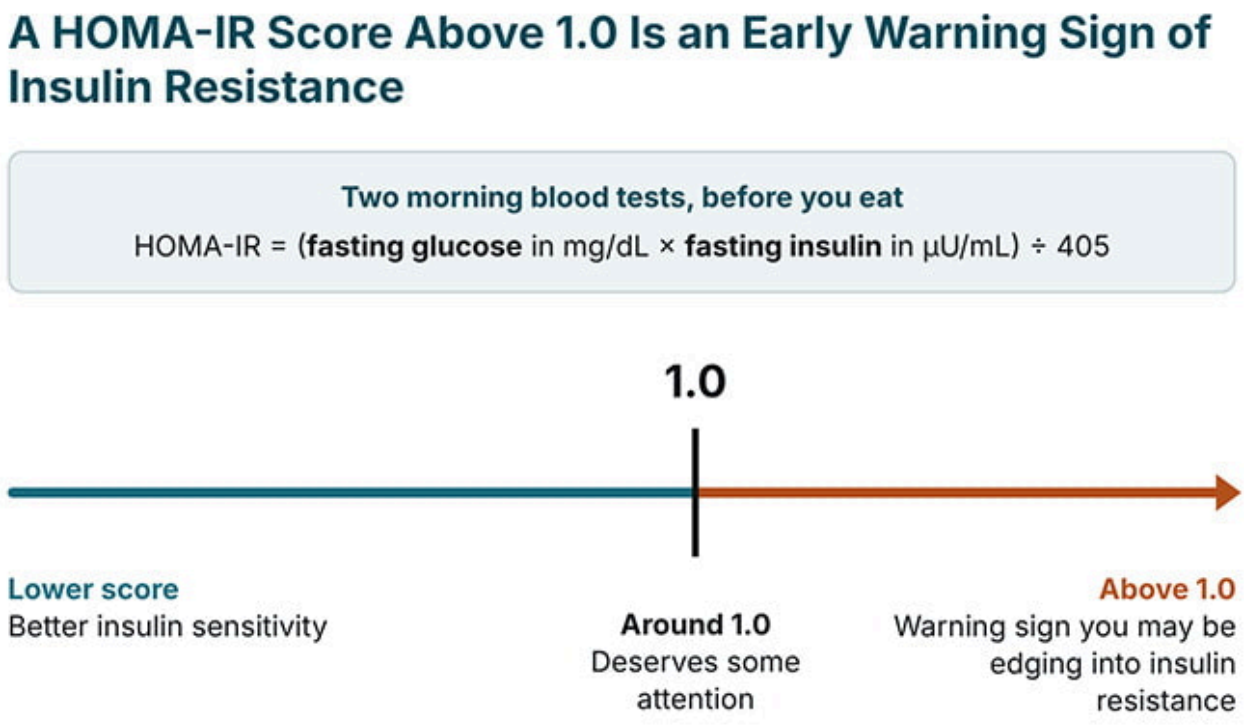

Figure 3. *HOMA-IR combines fasting glucose and fasting insulin into one score, and a result above 1.0 is a warning sign of insulin resistance.*

- **The beauty of HOMA-IR lies in its simplicity —** You don't have to schedule multiple visits or endure complicated test procedures. You wake up, don't eat or drink anything other than water, head to the lab for a quick blood draw, and get your results shortly after.
- **It's a far cry from the gold-standard research method known as the euglycemic hyperinsulinemic clamp —** This requires participants to be hooked up to an IV for hours. In the clamp procedure, researchers administer insulin and glucose simultaneously, measuring exactly how much glucose is needed to keep blood sugar at a steady level when insulin is being pumped in.

  Although extremely accurate, this process is time-consuming, expensive, and inconvenient, making it unfeasible for routine monitoring in a clinical or everyday setting.

That's why HOMA-IR remains such a powerful tool in both scientific research and personal health management: it balances accuracy with practicality. It's not a perfect snapshot — no single test can capture the full complexity of your metabolic health — but it's solid enough to highlight when your body starts resisting insulin's signals.

By catching those early warnings, you can make diet and lifestyle tweaks long before you slip into more serious issues. For most people, if your HOMA-IR creeps above 1.0, it's time to pay closer attention to factors like sugar intake, seed oils, plastic exposure, and gut health.

Over time, as you dial in these elements of your routine, you can retest HOMA-IR and see if your score drops. That direct feedback can be a potent motivator to keep you on track toward a healthier, more energetic life. Talk to your health care provider about whether this testing is appropriate for you.

Insulin Resistance and the Domino Effect on Metabolism

When insulin resistance takes hold, your entire system of metabolism begins to wobble. Metabolism is the sum of all the chemical processes in your body that create and use energy. Once insulin can't do its job well, your cells receive less glucose.

- **If your cells don't get glucose, they send signals to let your body know they're hungry —** Your brain receives these signals and responds by telling you to eat more. But if you eat more refined sugar or processed foods, blood sugar spikes again, your pancreas tries to produce even more insulin, and your cells resist even harder. This vicious cycle can go round and round for years.

- **As your cells resist the action of insulin, your body switches to burning more fats as an energy source —** But if that switch is not carefully balanced, it can lead to issues like high triglyceride levels, changes in cholesterol, and additional stress on your liver.

- **Your liver is a major player here —** When it becomes insulin-resistant, it struggles to properly regulate fat and glucose. This can lead to fat building up inside your liver, a condition known as **fatty liver disease**, and the domino effect continues.[10,11]

  This then impacts how your other organs function. Insulin resistance has been associated with high blood pressure and systemic inflammation, adding strain as insulin's job is compromised day in and day out.[12]

- **This downward spiral also extends to your gut health —** The community of helpful bacteria in your gut can be disrupted by poor diet, plastics, and synthetic chemicals. A troubled gut lining can then allow harmful substances, like endotoxin, to leak into your bloodstream, further fueling inflammation. Inflammation, in turn, has been linked to greater insulin resistance, which can propel the cycle forward.[13]

Meanwhile, your muscles and brain struggle to make the best use of the energy you do have. The overall effect is like a slow-burning fire that refuses to go out, draining your vitality little by little. Once you realize that insulin resistance can be at the heart of so many metabolic problems, you start to see why addressing it is one of the most crucial steps toward restoring balance and maintaining good health over a lifetime.

How Insulin Resistance Links to Mitochondrial Dysfunction

When insulin resistance limits the glucose entering cells, your mitochondria receive an inconsistent or insufficient supply of their most preferred fuel. It's like a power plant being forced to operate at reduced capacity, for lack of coal or natural gas.

- **Over time, this reduced capacity makes your mitochondria less efficient —** They begin to produce fewer molecules of the energy currency known as ATP. Without enough ATP, cells can't perform all their normal tasks, which affects tissues throughout your body — from your muscles to your brain.

- **Your mitochondria also need a stable environment to function properly —** Insulin resistance is often accompanied by increased oxidative stress. When your cells are unable to handle glucose correctly, there's a higher chance of harmful byproducts building up. These byproducts, called "reactive oxygen species" or ROS, are not automatically bad — they are part of normal metabolism.

  However, too many of them can damage your cell membranes, proteins, and even DNA. This kind of stress can further disrupt the function of the mitochondria, creating a feedback loop: unhealthy mitochondria add to insulin resistance, and insulin resistance keeps stressing the mitochondria.

- **Scientists have also noted that insulin resistance can alter how cells burn fat for energy —** In a healthy state, cells can switch smoothly between burning sugars and fats. However, when insulin signals aren't getting through, that switch doesn't happen as smoothly.[14]

  This can lead to a buildup of partially burned fuel in the mitochondria, which may increase reductive stress. Reductive stress, in turn, worsens oxidative stress. Also, toxins, like those found in plastics or introduced by heavily processed foods, can harm your mitochondria, making them more vulnerable.

Altogether, the relationship between insulin resistance and mitochondria appears to be a two-way street — though researchers still debate which comes first[15] — and each problem may intensify the other, and if you don't intervene, you can find yourself in a downward spiral of low energy, poor metabolic health, and chronic disease risk.

Ending the Cycle — Steps to Improve Insulin Sensitivity

Improving insulin sensitivity generally involves the gradual removal of barriers that stop insulin from doing its job. One essential shift is dietary: replacing refined sugars with whole foods. When you eat fruit instead of candy, for instance, the fiber and

micronutrients in the fruit help your body digest sugar more slowly, so you don't get the same insulin spike. This slower digestion means less stress on your pancreas and more stable blood sugar levels.

- **Another key dietary factor is limiting or completely avoiding damaged fats —** These include those found in vegetable oils such as soybean, corn, and canola oil. These seed oils can break down under heat and release substances that harm cells and disrupt insulin signaling.

- **Environmental factors are also crucial —** Plastics release chemicals that act like hormones or otherwise disrupt normal bodily functions. Reducing plastics in your kitchen — for example, by using glass containers or stainless-steel bottles — will lower your exposure.

- **Minimize unnecessary EMF exposure —** Turn off devices when not in use or keep them as far away from you as possible. Your cells can thrive when they aren't bombarded by stressors day and night.

- **Eliminate processed foods to protect your gut microbiome —** Gut health often improves when you swap out processed foods for whole, nutrient-rich meals that include vegetables, healthy fats like grass fed butter, ghee, and tallow, proteins, and complex carbohydrates. A healthier gut may mean fewer inflammatory signals, which may translate to better insulin sensitivity.

Regular movement — be it walking or more formal exercise — helps clear glucose from your blood. Muscle cells use up sugar quickly, lowering the demand on your pancreas to produce insulin. Overall, these adjustments may seem small, but combined, they can meaningfully shift how your body responds to insulin, helping you break the cycle linked to mitochondrial dysfunction and declining health.

Charting a Course Toward Better Health

By now, you've seen that insulin resistance is far more than just a "blood sugar problem." It's a metabolic challenge that can touch every corner of your well-being, from how your cells produce energy to how efficiently your mitochondria work. When most of the population displays some degree of insulin resistance, it becomes clear that understanding this issue isn't just for scientists or doctors — it's for anyone who wants to preserve or restore their health.

- **The good news is that many of the remedies are within reach —** Replacing processed foods and snacks with whole foods, and harmful seed oils with healthy cooking fats like grass fed butter, ghee, and tallow, reducing exposure to plastics and EMFs, and getting more physical movement every day are all practical strategies that may help improve your insulin sensitivity.

- **Remember that we're not demonizing sugar altogether —** In the context of whole foods — like fruits — sugar is packaged with fiber, vitamins, minerals, and other beneficial compounds that slow down its release into the bloodstream. The real problem arises when sugar is refined, extracted, and consumed in large amounts without those protective factors.

  Pair that with other stressors, like poor sleep, chronic stress, and toxic chemicals, and you can see how the body's delicate balance can be easily upset. Addressing insulin resistance is akin to mending an essential bridge in your metabolism, one that allows for the smooth flow of energy into the cells.

- **Small changes can add up —** Life is busy, and change can seem daunting, but small daily adjustments can accumulate to produce significant results. For example, a single day of choosing water over sugary beverages can reduce that insulin spike and give your body a chance to recalibrate. Over time, as your cells become more sensitive to insulin's signals, your energy levels stabilize, and your overall resilience improves.

This may not only help you feel better but also support your long-term health, lowering the odds of problems that might otherwise appear in the future. By focusing on insulin resistance now, you're supporting your body's natural healing systems and helping your cells and mitochondria get what they need to keep you strong, alert, and ready for all the fun and challenges life throws your way.

Insulin Resistance, Metabolic Dysfunction, and the Sorbitol Pathway

As previously explained, **reductive stress** happens when there are too many "loaded" electron carriers in your cells.

These electron carriers normally help convert food into energy by passing electrons to the mitochondria. Imagine the mitochondria as a major highway that keeps traffic moving smoothly. If too many cars (electron carriers loaded with electrons) crowd the highway and the lanes aren't clear, you get a traffic jam. This jam slows down the mitochondria's ability to burn glucose, and your body can't produce energy as efficiently.

- **When glucose isn't being burned properly, your body needs other ways to handle the excess —** When blood sugar is high, more glucose flows through alternative routes that transform the extra sugar.[16] One of these routes is known as the sorbitol pathway (also called the polyol pathway).

- **This important enzyme converts glucose to sorbitol —** In this pathway, an enzyme called aldose reductase converts glucose into a sugar alcohol called sorbitol, which is then changed into fructose by another enzyme.[17]

  At first glance, this might sound like a clever solution — rather than letting blood sugar run wild and harm your cells, the body funnels some glucose into another chemical pathway. However, just because it's a backup plan doesn't mean it's always good news. It's worth being clear about the evidence here — much of the classic research on this pathway comes from laboratory and animal studies.

For example, early work in rat lenses found that when glucose levels rise, sorbitol and fructose are formed faster than the lens can clear them, and the researcher described the pathway's normal function as "obscure."[18] The idea that it serves as a protective backup is a hypothesis, not an established finding.

- **When the sorbitol pathway kicks into high gear, sorbitol can build up in tissues that don't normally handle it —** Like nerves in your fingers and toes or the lenses of your eyes. Because sorbitol doesn't pass easily out of cells, it tends to accumulate — in the lens, early research found it formed faster than it could be removed[19] — and it is thought to draw water into cells, which may make them swell and become damaged over time.

This is one of several mechanisms proposed to explain why people with poorly controlled blood sugar can develop issues such as tingling in their hands and feet or even vision problems.[20] The sorbitol pathway isn't evil by itself; it's simply a tool the body uses when there's too much sugar floating around. The trouble begins when insulin resistance and high blood sugar turn that tool into a nonstop detour, overloading your cells day in and day out.

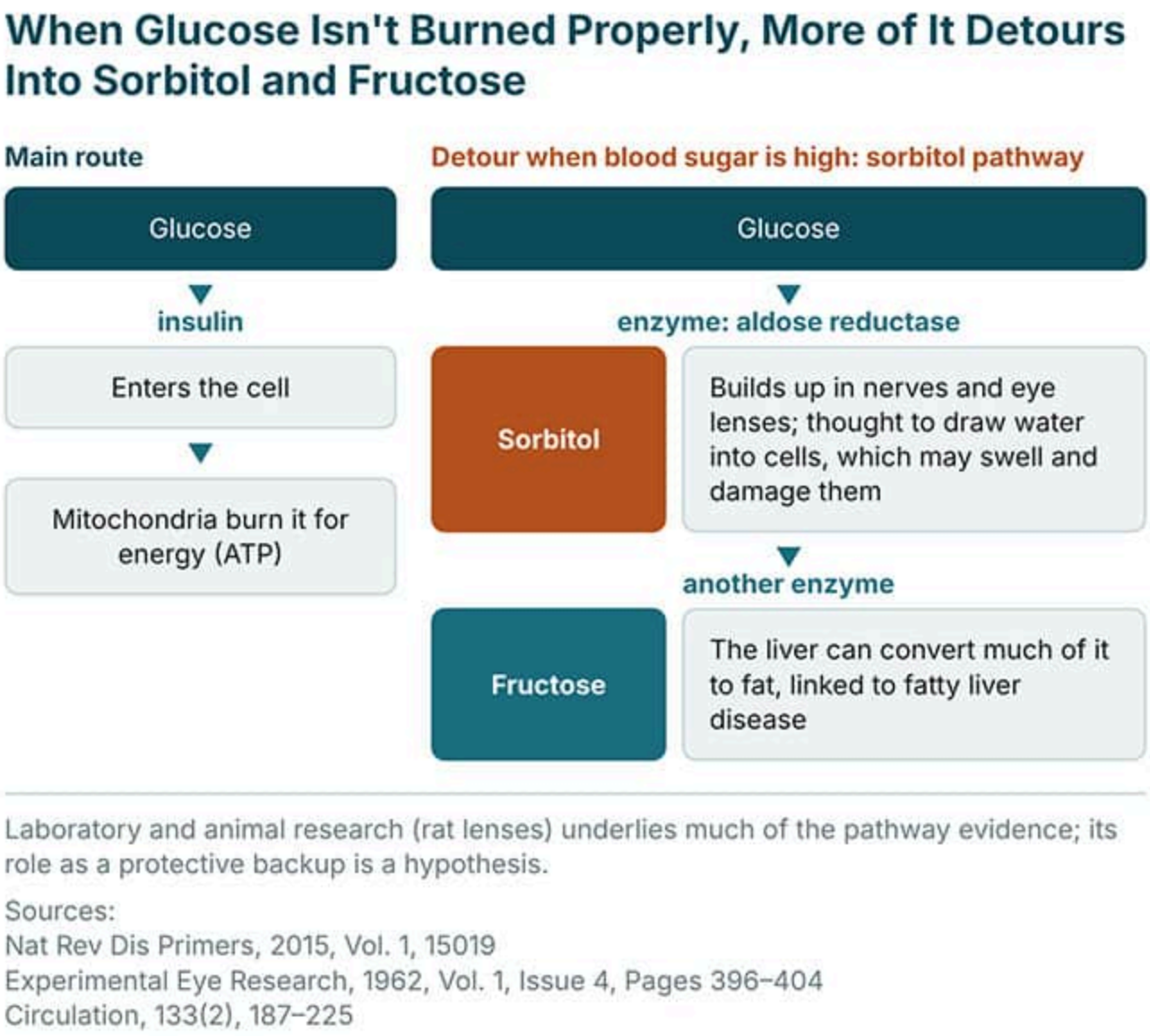

Figure 4. *When blood sugar is high, more glucose is routed through the sorbitol pathway, where sorbitol can build up in nerves and eye lenses and the resulting fructose can be turned into liver fat.*

Fructose Also Has Its Set of Hazards

The fructose produced through the sorbitol pathway also brings its own set of challenges. Only certain parts of the body, like the liver, can handle fructose efficiently.

- **What happens when there are excessive amounts of fructose, especially from refined sugars and sweetened drinks?** The liver can convert much of it to fat, which has been linked to fatty liver disease.[21] So, the body is stuck picking between a rock and a hard place: high blood glucose can cause harm right away, but converting that glucose into fructose only harms you more slowly.

  This detour has been described as a short-term strategy for coping with excessively high blood sugar. But as this pattern continues, you start risking long-term damage.

- **This damage includes many issues —** Insulin resistance may worsen, liver problems may develop, and other disorders like heart disease could develop down the line. It doesn't cause harm overnight, but over time it may wear your system down and contribute to chronic disease if the cycle isn't addressed.

How Fructose Overload Worsens Insulin Resistance and Mitochondrial Stress

Fructose is a type of sugar naturally found in fruits, which also contain fiber, vitamins, and other helpful nutrients. In whole fruits, fructose is released gradually, so it doesn't flood your system with sugar all at once. But in processed foods like sugary drinks, candy, and many packaged snacks, fructose is often refined (think high-fructose corn syrup) or used in large amounts, delivering a large sugar load all at once.

Unlike glucose, rapidly digested fructose has relatively little immediate effect on blood sugar, but it more directly drives fat production in the liver.[22]

- **This surge of fructose can then feed into the sorbitol pathway in a different way —** Instead of helping your body "take a break" from high glucose, an overload of fructose creates an environment where there's always too much sugar of one kind or another. Whether it starts as glucose or fructose, once your cells are overloaded, the sorbitol pathway works overtime.

The same scenario that applies to glucose overload applies to fructose overload: consistently pushing too much sugar (from any source) into your cells will make your body scramble for ways to protect itself.

- **Clearing sugar from your bloodstream becomes more difficult due to insulin resistance —** If insulin resistance is already present — meaning your cells aren't responding well to insulin — it becomes even harder to clear sugars from your bloodstream. Extra fructose ramps up the pressure, and you end up with sorbitol and fructose swirling around, forcing your liver to work overtime and potentially harming nerves, eyes, and other tissues.
- **Your mitochondria also remain under strain —** Reductive stress lingers because too many loaded electron carriers are waiting in line, and not enough are being used effectively for energy production.
- **Shifting sugar into the sorbitol pathway might temporarily reduce blood sugar levels —** However, the original problem — impaired mitochondrial function — may not go away. When this cycle of insulin resistance, high blood sugar, and sorbitol buildup persists for weeks, months, or even years, it sets the stage for chronic metabolic dysfunction.
- **Lowering your blood sugar with medication can be important, but on its own, it may not address everything —** The deeper issues like overwhelmed mitochondria and ongoing reductive stress may remain. If those aren't addressed, your body may keep seeking detours, activating more stress responses, and damaging delicate tissues along the way.

How to Break the Cycle

So, how do you break this vicious cycle? One major step is to manage the amount and type of sugars you eat. There's a huge difference between the moderate amounts of fructose found in whole fruit and the massive spikes of refined sugar in certain drinks

and desserts. Reducing the intake of high-fructose snacks and beverages can lessen the need for these chemical detours.

- **Another key step is improving your insulin sensitivity —** This can be done by eating balanced meals with enough protein, healthy carbohydrates, and healthy fats, staying physically active, getting good quality sleep, and avoiding constant stress. When your insulin sensitivity is better, glucose can enter cells more easily via the normal "highway," making the sorbitol pathway less necessary.

- **Remember, not all carbohydrates are the enemy —** Whole fruits, vegetables, and white rice provide carbohydrates along with important nutrients, and eating them as part of a meal with protein and fat helps moderate how quickly sugars enter your bloodstream.

  That means your pancreas doesn't have to pump out as much insulin at once, and your cells don't get overwhelmed with incoming sugar. With proper balance, your body has less need to rely on backup plans like the sorbitol pathway, and you reduce the chance of ending up in that uncomfortable cycle of damage and stress.

  Ultimately, understanding the sorbitol pathway and the role of fructose isn't just about memorizing new vocabulary. It's about realizing that your body works like a finely tuned machine that has multiple ways to handle fuel.

If the main way (insulin-driven glucose uptake) starts to fail, other routes (like the sorbitol pathway) take on more of the load — but at a cost. By keeping insulin resistance under control, moderating fructose intake (especially from processed sources), and giving your mitochondria a break from electron "traffic jams," you can help your cells stay healthy.

This may mean feeling better, having more energy, and avoiding many of the problems that come with too much sugar and too little metabolic balance.

The Surprising Truth About White Rice

White rice often gets a bad reputation in today's nutrition world, especially when compared to brown rice. However, in the context of insulin resistance and impaired mitochondrial function, white rice may be the better choice for many people. One of the main reasons for this has to do with the kinds of fiber found in brown rice and many other whole grains.

- **Different types of fiber have different functions —** While fiber is generally considered beneficial, not all forms of fiber work the same way in every person's body. In individuals who have impaired gut health or insulin resistance, many fibers can feed harmful bacteria in the colon, which may lead to a rise in endotoxins — compounds that fan the flames of inflammation throughout your body.

- **Processing affects the quality of brown rice —** When brown rice is processed into white rice, the outer bran and germ layers (which contain the majority of the fiber and certain fats) are removed. This bran is rich in fiber that may be beneficial for some people, but for those already dealing with excessive pathogenic (disease-causing) bacteria in their gut, this fiber becomes food for the wrong microbes.

  As these bacteria feast, they produce more endotoxins, which can move through the intestinal wall and enter the bloodstream. Your body then mounts an inflammatory response, which can worsen insulin resistance and put extra stress on your mitochondria.

- **Individuals with insulin resistance often have compromised gut health to begin with —** The delicate balance of bacteria in their intestines is already off-kilter, and even otherwise healthy fiber can feed the bacteria that trigger harmful cascades of inflammation.

- **Why white rice is better for most individuals —** While removing fiber from rice might seem counterintuitive — since fiber is usually recommended to keep digestion smooth — it's better for people with these specific health challenges to reduce fiber

sources that worsen endotoxin production. White rice, stripped of most of its bran and germ, is easier for your body to digest and less likely to aggravate bacterial imbalances.

- **Another crucial difference between white and brown rice involves the types and amounts of fats present —** Brown rice, along with many other whole grains, contains oils that are relatively high in omega-6 fats. Although small amounts of omega-6 fat are essential, most people in modern societies consume far too much. Ideally, keep your intake of linoleic acid — the main omega-6 fat — below 5 grams a day.

- **Excess omega-6 can shift the balance of fats in your cell membranes and may promote mitochondrial damage —** This is particularly relevant for those suffering from insulin resistance and reductive stress, because a backup in electrons in the mitochondrial electron transport chain (ETC) may further hamper your mitochondria's ability to produce energy.

  Mitochondria need a stable and well-regulated environment to function at their best, and constant exposure to inflammatory signals degrades their performance, making insulin resistance worse.

- **White rice, having most of its bran removed, ends up being much lower in these omega-6-rich oils —** This means that by opting for white rice over brown, you're not only sidestepping certain problematic fibers but also reducing your intake of extra omega-6 fats that can make mitochondrial dysfunction and insulin resistance worse.

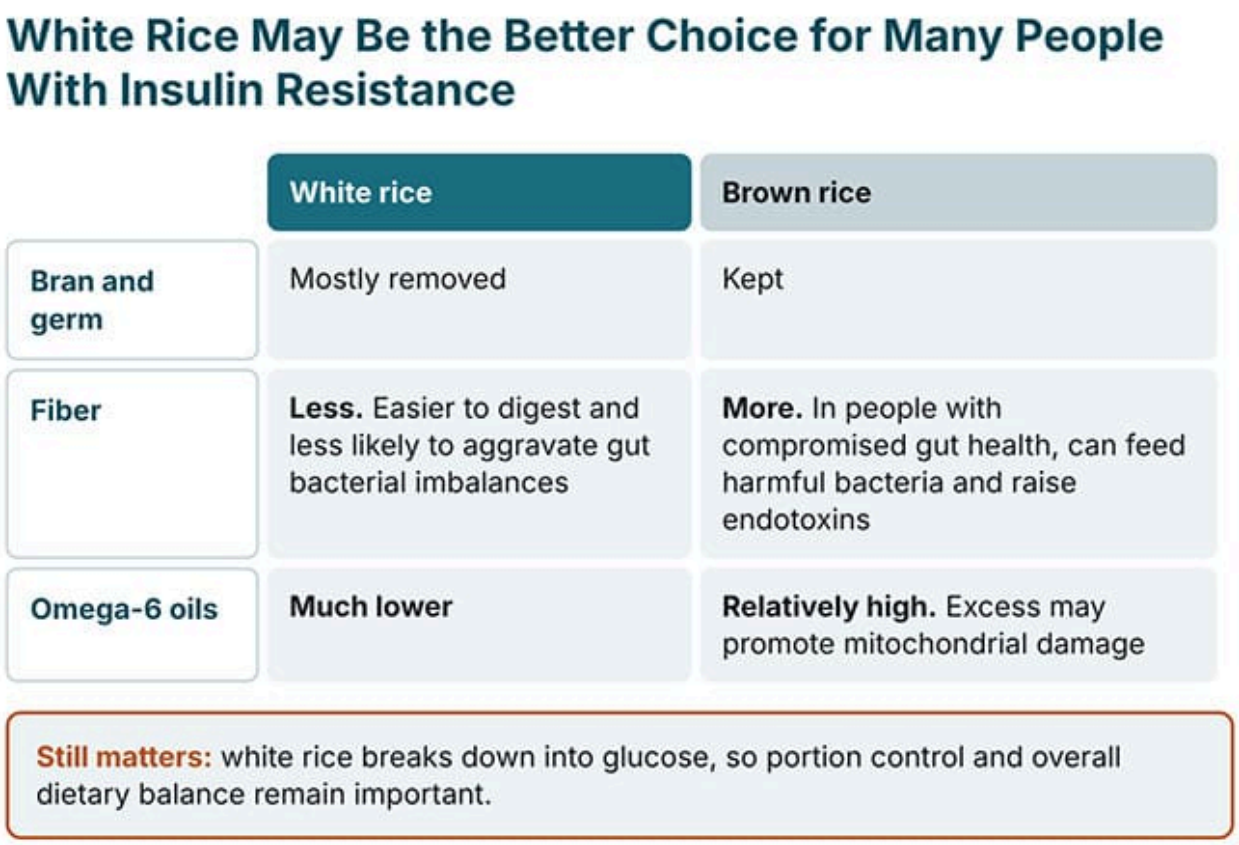

Figure 5. *Removing the bran and germ leaves white rice with less fiber and much lower omega-6 oils than brown rice, which may make it the better choice for many people with insulin resistance.*

- **This doesn't mean white rice is free of all concerns —** It still breaks down into glucose, so portion control and overall dietary balance remain important. But in a world where many people already battle too much inflammation, too many harmful gut bacteria, and too high a load of omega-6 fats, white rice is a cleaner, simpler carbohydrate source.

  It's also worth noting that white rice has long been a staple in cultures where metabolic conditions like obesity and diabetes were historically less common. Historically, people in these regions paired white rice with protein, vegetables, and other nutrient-dense foods, making sure not to rely solely on rice for their nourishment.

It's this comprehensive approach — avoiding excessive sugar, managing total omega-6 intake, and keeping disease causing gut bacteria in check by being selective about your fiber intake — that may best support healthy metabolic balance. When used wisely in a balanced diet, white rice provides an easily digestible and less inflammatory option, especially for those struggling with insulin resistance and compromised mitochondrial function.

Removing the Causes of Reductive Stress

A more lasting approach to insulin resistance is to reduce whatever drives reductive stress in the first place:

- **Start eating healthy —** That means cutting back on vegetable oils and seed oils, soft drinks, and processed foods with artificial ingredients, and eating more nourishing foods like vegetables, fruits with their natural balance of nutrients, and clean proteins. This helps your mitochondria burn fuel more smoothly.
- **Another important step is moving your body daily —** Whether it's sports, dancing, or other activities, being physically active helps your cells use stored glucose.
- **Over time, these changes may reduce reliance on the sorbitol pathway and the buildup of harmful fructose —** The idea is that if you supply your cells with good fuel and keep them from being overrun by poisons, your body may not need to lean as heavily on backup pathways linked to further damage.

The Role of Mitochondrial Helpers Like Methylene Blue

In some situations, a substance called methylene blue may help reduce the traffic jam inside mitochondria. Think of it like a traffic officer who temporarily helps direct cars (electron carriers) into open or less crowded lanes.

- **Methylene blue may help your body use glucose more efficiently —** It is thought to act as an alternative electron carrier that temporarily helps mitochondria burn glucose more efficiently, rather than shunting it toward fructose or letting it build up in the blood. As such, it may help with the immediate stress on the system.
- **Methylene blue is not a magic remedy —** If someone goes back to guzzling soda and consuming chemical-laden foods right afterward, they'll soon be back in the same predicament.

If you're considering methylene blue, use it only under the guidance of a health care professional who can prescribe it. It should be pharmaceutical-grade, in capsule or tablet form, and obtained from a compounding pharmacy. The dose typically discussed for reductive stress is 5 milligrams once a day, regardless of body weight. That said, methylene blue can interact with certain medications, including some antidepressants, so review everything you take with your provider first.

So, while methylene blue can be a useful tool, it doesn't solve the underlying causes of metabolic illness. It's just a way to relieve the pressure in moments when the system is overwhelmed. True long-lasting health still depends on proper nutrition, exercise, good sleep, and avoiding the mitochondrial poisons that create reductive stress.

Becoming the Caretaker of Your Own Power Plants

Remember, metabolic dysfunction doesn't happen overnight. It often reflects repeated exposure to unhealthy foods and hidden chemicals that damage your mitochondria. By recognizing how your cells work and why they switch to the sorbitol pathway under stress, you understand that your body often chooses short-term safety over long-term health.

Left unchecked, this can lead to a slow breakdown of tissues and organs, with fatty liver disease, heart issues, and other serious conditions becoming more likely. However, you have the power to break this cycle by making conscious choices about diet and exercise.

If your mitochondria stay clean and free of poisons, they are less likely to jam up the system, causing reductive stress and pushing glucose down the fructose route. While something like methylene blue might help in a pinch, it's far better to avoid the crisis altogether.

That way, you don't rely on rescue measures and can enjoy more consistent energy and better overall health, with less of the burden linked to unaddressed metabolic dysfunction.

Each step — like removing sugary snacks, picking whole foods, and staying active — helps protect these tiny power plants, so you can feel more energetic, think more clearly, and live with more zest. When you become the caretaker of your mitochondria, you're setting yourself on a path to a long, healthy life, free from the constant worry of metabolic problems.

Frequently Asked Questions (FAQs) About Insulin Resistance

Q: What causes insulin resistance, and why is it so common?

A: Insulin resistance has been linked to a combination of high intake of refined sugars, seed oils (like soybean and corn oil), environmental toxins (such as plastics and EMFs), poor sleep, chronic stress, and sedentary lifestyles. These factors are thought to damage mitochondria and disrupt insulin signaling. More than 99% of Americans are estimated to have some degree of insulin resistance, which modern diet and lifestyle are thought to drive.

Q: What is the sorbitol pathway, and how does it harm the body?

A: When cells become insulin-resistant and can't use glucose effectively, more of the excess glucose is converted into fructose via the sorbitol pathway, which has been described as a backup mechanism. Although this may help limit very high blood

sugar in the short term, heavy use of this pathway has been linked to long-term damage to tissues and nerves, and the fructose it produces may add to strain on the liver and to insulin resistance over time.

Q: How can you detect insulin resistance early?

A: The HOMA-IR blood test is a simple, affordable way to measure insulin resistance. It uses fasting insulin and glucose numbers. A score above 1.0 may signal early insulin resistance, suggesting it's time to adjust diet, reduce exposure to toxins, manage stress, and increase physical activity.

Q: Is white rice really better than brown rice for people with insulin resistance?

A: For many people, it may be. White rice has less fiber and lower omega-6 oils than brown rice. For individuals with compromised gut health or insulin resistance, the fiber in brown rice can feed harmful bacteria and increase inflammation, while excess omega-6 fats can worsen mitochondrial damage.

Q: How can insulin sensitivity be improved naturally?

A: Insulin sensitivity may be improved by eliminating refined sugars, seed oils, and processed foods; reducing exposure to plastics and EMFs; prioritizing sleep and stress management; eating balanced whole-food meals with healthy carbs, protein, and fats; and moving your body daily to use glucose effectively and reduce metabolic strain.

This article is for informational purposes only and does not constitute medical advice. Consult a qualified health care provider before making changes to your health regimen.

Sources and References

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