

Title: “SUGAR IS AS BAD AS ALCOHOL”

[Open with Homer: “[To alcohol...](#)” ?]

We’re all familiar with the dangers of alcohol and the fact that frequent alcohol consumption can fry your liver. [*Barney Gumble - “Dibs on the liver!” clip*] Anyone who has had alcohol before will not doubt that it is a toxin, even if they are not familiar with what it specifically does inside your body. This is because you can experience the immediate or “acute” effects of alcohol exposure in a single night after just a few drinks. You might not notice your heart rate becoming irregular, your blood vessels dilating, or your loss of fine motor control, but you will notice something is different as you become “drunk” or “intoxicated”. Then if the pleasant feeling of being drunk had you doubting whether or not alcohol is a toxin, the hangover that comes the next day will surely confirm that it is. So you don’t really need much education or convincing about whether or not frequent consumption of alcohol has some potentially serious effects on your health.

The reason you can feel the effects of alcohol right away and get “drunk” is because a little bit of the alcohol is metabolized by the brain. Actually what goes to the brain is less than 10% of the alcohol you drink. The majority of it- about 80% gets metabolized by the liver. This is why you can develop all sorts of serious liver issues quite quickly if you’re drinking on a daily basis. However, your liver **is** a very powerful organ that can handle various toxins relatively well, so one night of celebrating your birthday at the bar isn’t going to have you trying to get on the liver transplant list.

So what if we could make an alcoholic drink with a special type of alcohol that didn’t get metabolized in the brain, so you wouldn’t experience the acute effects of alcohol toxicity? You could have several beers at lunch and still be sharp as a tack during the company meeting at 2PM. Maybe you’d even be allowed to drink and drive because it wouldn’t impair your motor skills. Companies might even get away with marketing this special alcohol to kids. [*Cut in WKUK “Kid Beer” clip*] Hey I mean if the kid isn’t slurring his words and falling down, it should be OK right? ...Of course not, no parent in their right mind would give their kid alcohol simply because they don’t *appear* drunk. You wouldn’t want to set your kid up to fry his liver before he’s even left grade school.



So here are the immediate health effects, and the long term health effects that come with alcohol consumption. How would you feel about a substance that doesn't get metabolized in the brain, so you get none of these and you only have to worry about **8** of these 12 problems? ...Still not OK that, I'm betting.

Ethanol (Acute exposure)	Ethanol (Chronic Exposure)	New Alcohol! (No acute effects!)
CNS Depression	Hematologic disorders	
Vasodilation	Electrolyte Abnormalities	
Hypothermia	Hypertension	Hypertension
Tachycardia	Cardiac Dilation	
Myocardial Depression	Cardiomyopathy	Heart Disease
Variable Pupillary Responses	Dyslipidemia	Dyslipidemia
Respiratory Depression	Pancreatitis	Pancreatitis
Diuresis	Malnutrition	
Hypoglycemia	Obesity	Obesity
Fine Motor Control Loss	Steatohepatitis	Non Alcoholic Fatty Liver

	Fetal transmission	Fetal transmission (IR)
	Addiction	Habituation & Addiction

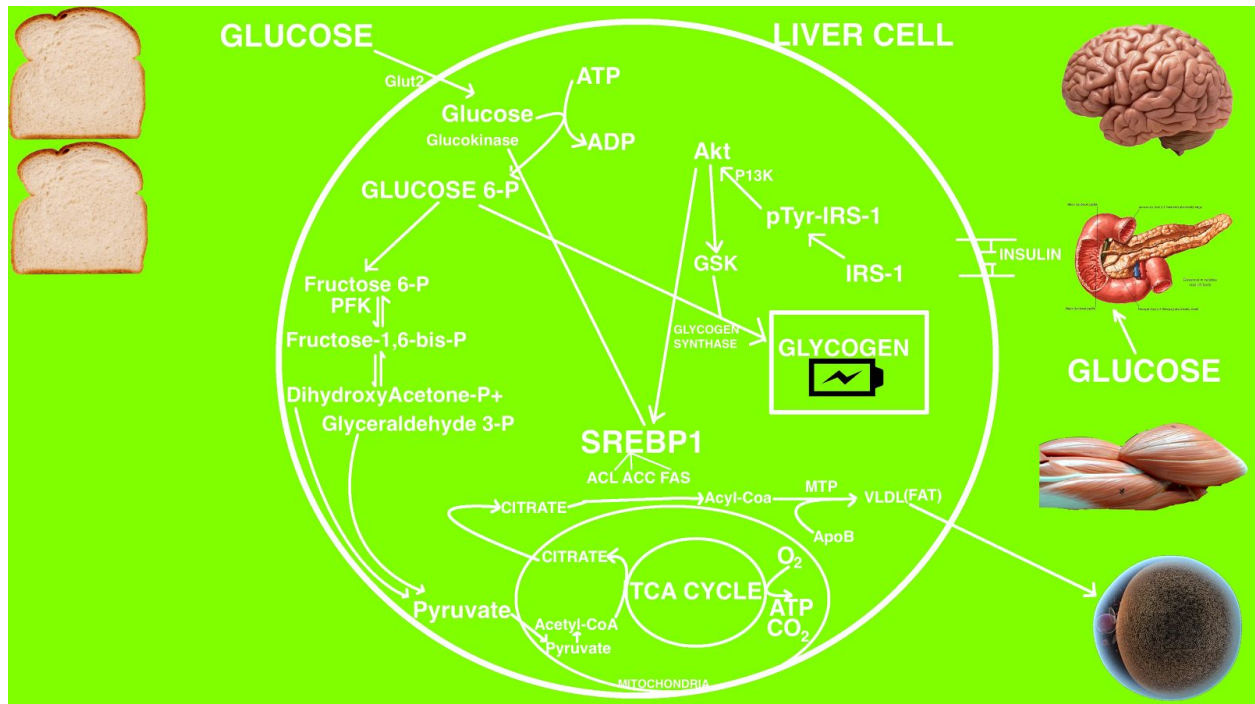
Well we already have a substance like this that is consumed on a daily basis. Like alcohol, it's not necessary for any biochemical reaction in the body, you don't need it to survive. It's not metabolized in the brain so it doesn't get you drunk, but like alcohol and other toxins, it's processed primarily in the liver. And frequent consumption of it leads to all sorts of health problems. This substance is fructose. Table sugar, sucrose, is made up of one molecule of glucose and one molecule of fructose. Fructose is in honey, it's in fruit juice, it's in high fructose corn syrup - it's what makes the really sweet stuff sweet.

[Roll [Robert Lustig](#) Clip "*You wouldn't think twice about giving your kid a budweiser...*"] This is Robert Lustig, he is probably **the** biggest factor in bringing the detrimental effects of sugar to light. At first, he can sound a bit over the top when talking about sugar. [Roll Lustig Clip saying "This is not hyperbole... sugar is a poison"] However, he can back all his statements up with more than 16 years of medical research, academic discourse, policy analysis, data analysis, a whole lot of patient care and maybe most important: the biochemistry of how sugar is processed in the body.

While there are all sorts of compelling statistics we could talk about, the actual mechanisms that cause sugar to have such bad effects on the body paint a much clearer picture. Once you understand how it is processed in the body, it leaves very little debate as to whether or not sugar could be considered a toxin, and you start to see how a lot of modern health issues are caused by sugar.

Let's look at how sugar is metabolised as illustrated by Dr. Lustig in his presentation "Sugar: The Bitter Truth," as well as his 2012 book "Fat Chance" and this 2011 paper funded by the NIH. But first we'll look at glucose or "starch" to see how a non-toxic carbohydrate is metabolized. [Overlay rice, bread, pasta .]

By the way, it's not necessary to remember all these specific terms that come up. Just pay attention to how glucose flows through the cell so you can see how it's different from alcohol and sugar.



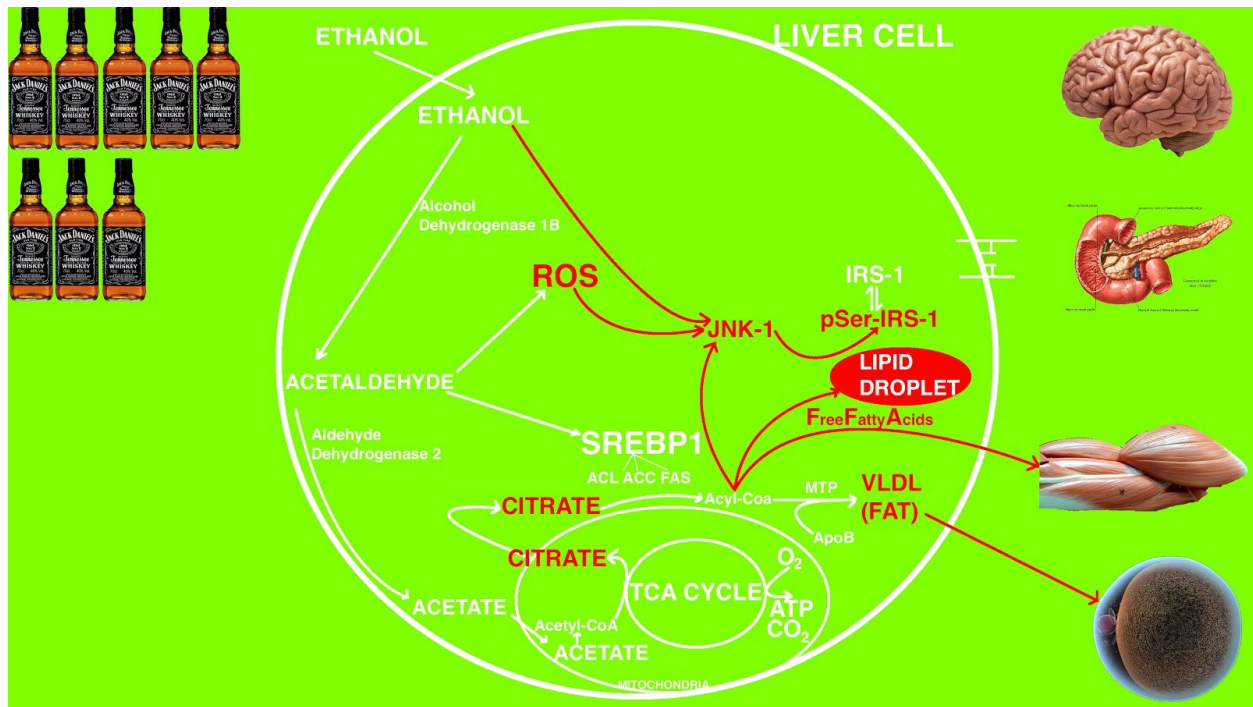
GLUCOSE METABOLISM

So here is what's happening in your liver when you eat something like a slice of white bread. First off, only 20% of the glucose you ate will actually hit the liver because the other 80% is metabolised by all the other cells in your body. Before glucose can get into the cell, it needs to stimulate the pancreas to make insulin. The insulin will stimulate this insulin receptor IRS-1, which causes a series of reactions to stimulate SREBP1 and active this enzyme called glucokinase. Glucokinase takes glucose to Glucose 6-Phosphate which mostly gets stored in the liver as Glycogen. Glycogen is a good thing because it acts as a reserve tank of energy that your body can access when necessary. This is why runners will "carb load" before a race- to completely fill up their glycogen stores and have more energy during the race than what is just sitting in their gut.

What doesn't go to glycogen gets metabolized down to pyruvate. Pyruvate enters the mitochondria, which is like the coal furnace of your cell because it converts the Pyruvate to Acetyl-CoA then burns that in the TCA cycle to produce a bunch of energy in the form of ATP. Not all of it is gonna get burned off so a little bit may be left over as citrate. The SREBP1 from before activates three enzymes start a process called de novo lipogenesis. De novo "new" lipo "fat" genesis "making". So the cell is taking this leftover citrate and converting it into fat. The liver really doesn't want fat sitting around inside it, so some of it gets converted down to something called VLDL which is stored in your fat tissue. Not only is this making you fat, but VLDL is particularly important because it is a big contributor to heart disease.

While this might sound bad, it's actually not that big of a deal because remember: only 20% of the glucose made it to your liver, then half of that went to glycogen, then some of that is burned off for energy, so maybe 1/50th of what you ate will actually turn into VLDL. So could a

Japanese farmer eating rice and vegetables at every meal die from a build up of heart disease causing VLDL? Maybe. But it's gonna happen when he's around 90 years old, so that's not too bad.



ETHANOL METABOLISM

So now let's look at ethanol, which is the same thing as "drinking alcohol" to see what makes it so different from glucose. Here's what happens in the liver when you have some hard liquor.

As you can guess, ethanol is not necessary for any biological process, so a majority of it will be processed like a toxin in the liver. 10% will get processed in the stomach and intestines and another 10% gets processed by the kidneys, muscle and the brain. This is the first big difference between glucose and ethanol, the liver has to work 4 times as hard because it processes 80% of the alcohol. Ethanol doesn't need insulin to get into the cell, it just diffuses in there and is converted to acetaldehyde. Acetaldehyde generates something called reactive oxygen species. Reactive oxygen species damage proteins in the body, can cause cancer and are thought to be the key factor in aging. This is why anti oxidants are supposed to combat aging, because they deal with these ROS's. This is also why alcoholics or heavy drinkers can sometimes look 10 years older than they should.

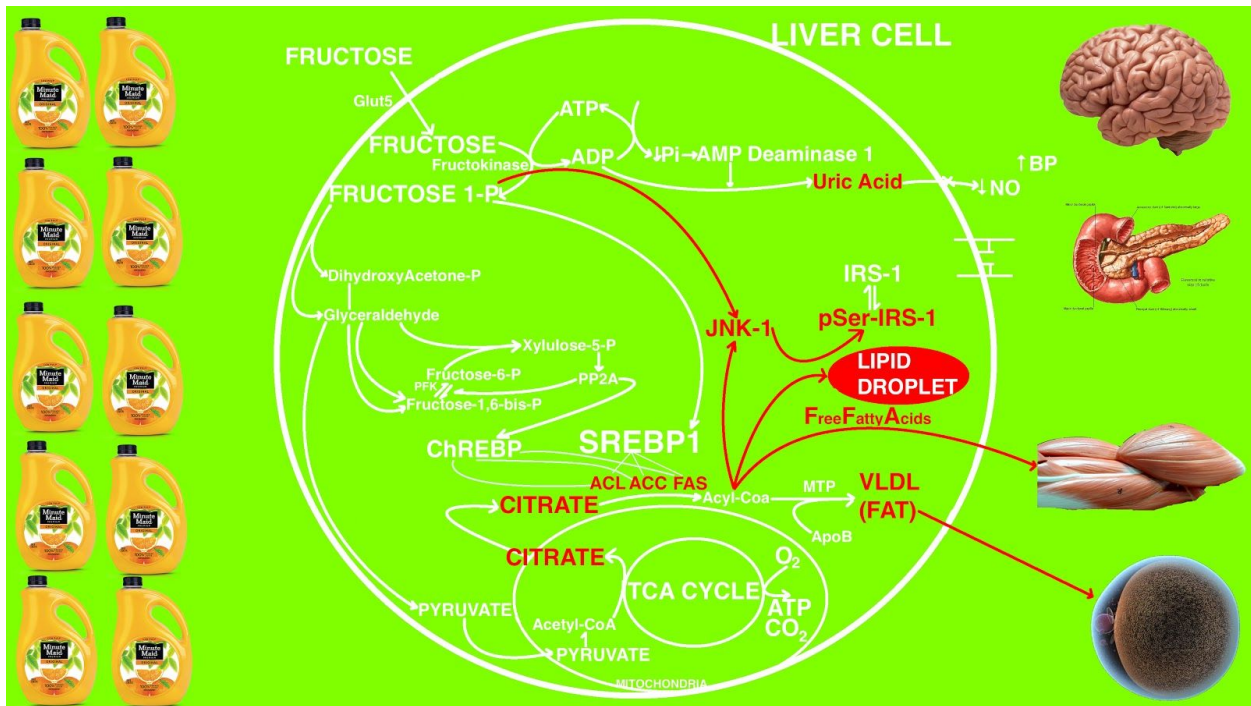
The acetaldehyde then gets converted to acetate and goes into the mitochondria like last time. With glucose, only went to the liver and then maybe half of that went to the liver mitochondria because the rest went to glycogen. So what alcohol is doing is overloading your mitochondria. A bunch of acetate comes in, goes through the TCA cycle and you're left with a ton of citrate. The same three enzymes start "new fat making" and you end up with a lot of bad fat. This will go to your fat stores, primarily your visceral fat. This is the stuff that causes a lot of health issues and

surrounds your organs, giving you a big gut. This is why people get “beer bellies” because that’s the area that gets filled with the fat.

So the liver has all this fat being produced that it doesn’t want sitting around inside it so it will also export some of the fat out in the form of free fatty acids. These can get into the muscle, which causes muscle insulin resistance, which is very problematic. Some of it won’t even be able to get out, so you have a fat droplet sitting around in the liver and now you have your alcoholic fatty liver disease. [Windows [Ja jan!](#) noise]

Now this excess of Acyl-CoA, the ethanol and the ROS species activate an enzyme called JNK1 which is the bridge between metabolism and inflammation. This ends up further damaging the liver and it promotes insulin resistance within the liver by inactivating IRS-1, the insulin receptor from before. This means your pancreas has to work a lot harder and pump more insulin out to do its job.

So this is how alcohol can really muck up your liver, cause you to age faster, put stress on your pancreas, cause you to gain weight and even cause insulin resistance.



FRUCTOSE METABOLISM

Sugar is made up of equal parts glucose and fructose. Let’s look at fructose and how it is metabolized very similarly to ethanol. Here’s what’s going on in the liver when you have a glass of orange juice.

So first off - like Ethanol, Fructose is not necessary to the body so it’s treated like a foreign substance and almost 100% of it is processed in the liver. It comes in, gets metabolized down to

pyruvate and enters the mitochondria. Now we have the same situation where everything goes straight to the liver, does not get stored in glycogen and overloads your liver cell's mitochondria. The pyruvate goes through TCA cycle, produces a bunch of citrate and gets converted down to VLDL. This leads to increased risk of heart disease and visceral fat accumulation. Now you've got a "soda belly". Like before, it exits the cell as free fatty acids leading to muscle insulin resistance. Not all of the fat can get out of the cell so fat accumulates in the liver and you get **non** alcoholic fatty liver disease. The same JNK1 gets stimulated which promotes inflammation and JNK1 acts on the insulin receptor causing insulin resistance in the liver.

All of this is illustrated in the movie "That Sugar Film." Damon Gameau goes on a diet with plenty of low fat and so called "healthy" foods like yogurt, whole grain cereals, fruit juice and fruit smoothies. The aim is to eat foods marketed as "healthy" while reaching the average sugar intake of a typical Australian which is about 40 teaspoons. His results demonstrate all of these biochemical processes we just talked about. He gained 8.5kg and an extra 7% total body fat mainly in the form of visceral fat, his heart disease risk went up, he's developed insulin resistance and after only 18 days he developed non alcoholic fatty liver disease. What I thought was interesting was that he didn't change the amount of calories he was consuming yet he packed on such a significant amount of fat.

Actually there's another element to fructose metabolism that makes it generate so much fat. Fructose forms something called Xylulose 5-Phosphate, and this further stimulates the de novo lipogenesis enzymes, leading to even more fat making. There's your obesity epidemic.

Also, when it's getting converted to Fructose 1-Phosphate it produces Uric Acid. Increased Uric Acid means higher blood pressure and now you have hypertension. Also, due to the pancreas having to pump out excess insulin due to the insulin resistance caused by these reactions, your brain can't pick up on its leptin signal so it thinks it hasn't been fed and you stay hungry. Ever had a couple sodas before lunch and thought "Man that soda really filled me up!" and skipped your lunch? Me neither.

Oh and coke still wants to pretend that obesity is all about calories and a calorie is just a calorie no matter where it comes from.

One thing I should mention is that fiber helps prevent the sugar in fruit from becoming a problem. Fiber reduces the rate of intestinal absorption meaning your liver can easily handle the steady stream of sugar from a piece of fruit. The fiber will also fill you up. So 4 apples might be a lot of food to take in in one sitting, but you can get 4 whole apple's worth of sugar delivered to your liver from one glass of apple juice in a few seconds.

One night of tequila shots isn't going to cause your liver to explode, but having a shot of whiskey with every meal and for a snack would do some serious damage. By the same token, having a big piece of cake with ice cream at a birthday party isn't that big of a deal, but most of us are loading up on sugar all throughout the day without noticing it. We'll have a so called "healthy"

breakfast of juice and cereal, then some starbucks pseudo-milkshake on the way to work, have a sandwich with low fat yogurt for lunch, a granola bar for a snack, then some pasta with a salad for dinner. But we're not realizing that that the yogurt has as much sugar as candy, the granola bar has as much sugar as a package of oreos, and even your pasta sauce and salad dressing has sugar pumped into it. 80% of the 600,000 packaged food items on the market have added sugar in them. By the way, they're not gonna have any of that protective fiber you find in whole fruits or vegetables. The fiber has been removed to improve shelf life of the products.

The average American child sees 30,000 TV commercials a year advertising fast food or candy. While something kid beer sounds joke-ish-ly evil, maybe it's not all that different from these fun, colorful sugar packed items kids have access to wherever they go.

Close with Lustig's "Sugar might be worse can only drink yourself under the table once a day"

Materials:

["Sugar: The Bitter Truth"](#) Lecture

["Fat Chance: Fructose 2.0"](#) Lecture

["Is a Calorie a Calorie?"](#) Lecture

["Toward a Unifying Hypothesis of Metabolic Syndrome"](#) NCBI Paper

["Fat Chance"](#) Book - Robert Lustig

["That Sugar Film"](#) Documentary/Movie

*Confirmed some things on ["BioGrid"](#)

Other (*Probably won't end up using*):

["The Secrets of Sugar"](#) CBC Special

["Sugar Crash"](#) Documentary

["Sugar Coated"](#) Documentary

["Fed Up"](#) Documentary

["Jamie's Sugar Rush"](#) Documentary

["The Truth about Sugar"](#) Documentary

["Sugar, the Kiss of Death"](#) Lecture (*Take some of the content in here with a grain of salt*)

["Pure, White and Deadly"](#) Book - John Yudkin