SUGARS – THE BASICS

Sugar plays a role in cardiovascular disease and obesity.
Sugar is habit-forming. It's 8x more addictive than cocaine.

Sugar can be grouped into 2 categories:

1) Naturally Occurring sugar
2) Added sugar or "sweeteners".

Naturally occurring sugars are monosaccharides (simple sugars) and consist of:

A) ***Fructose*** – in fruit and honey. It is the sweetest of all sugars.
B) ***Glucose*** – some vegetable
C) ***Galactose*** – dairy

Added sugars are everything else. Anything you add to foods is in this category.

Sucrose (table sugar, white or brown) is a disaccharide consisting of 50% fructose and 50% glucose and is refined from sugar cane or sugar beets.
High Fructose Corn Syrup (HFCS) also is a disaccharide and consists of 55% fructose and 45% glucose and is produced from industrially processed cornstarch.

Because of massive government subsidies, HFCS is the dominant sugar used in industry since it is so cheap.

Sucrose and HFCS are metabolically similar since the differences between the concentrations of fructose and glucose are similar but the two components are metabolized quite differently

After ingestion, sucrose and HFCS are broken down in the gut into their components fructose and glucose. After absorption, they travel to the liver where there is almost complete extraction of fructose and its metabolism. Its breakdown products are linked to:

- Endothelial dysfunctions (the cells that line your arteries)
- insulin resistance
- liver lipogenesis (fat production) and triglyceride elevation leading to visceral (internal organ) fat deposition

Americans consume 5x more fructose (in its artificial form) than we did a century ago and it has more than doubled in the last 30 years.

Although if you read labels and ask questions, you will see that added sugar is in everything, the main source of sugar is in the form of sugar-sweetened beverages.

The World Health Organization recommends no more than 25 grams of added sugar consumption a day. Our USDA is more generous, doubling that number.
How Does Sugar Make You Fat
Different foods affect the body in different ways and sugar is uniquely fattening.

Sugar (sucrose) and high fructose corn syrup contain two types of sugar molecules: *glucose* and *fructose*. Glucose is absolutely vital to life and is an integral part of our metabolism. Although we have a constant reservoir of it in the bloodstream, our bodies, particularly the liver, produce it out of proteins and fats if we don't have enough of it around. Every cell in the body can use glucose for energy. Our brain is the heaviest glucose user (80% of it).

Fructose, however, is very different. This molecule is not a natural part of metabolism and humans do not produce it. In fact, very few cells in the body can make use of it except liver cells. When we eat a lot of sugar, most of the fructose gets metabolized by the liver where it gets turned into fat, which is then secreted into the blood.

Insulin is one of the key hormones that regulate human metabolism and energy use and storage. It is secreted by the pancreas, then travels in the blood to peripheral cells like muscle cells. Insulin sends a signal to these cells that they should put transporters for glucose onto their surface, thereby allowing glucose to get into the cells where it can be used. When we eat a high carbohydrate meal, glucose levels go up. Excess glucose is toxic so insulin rapidly goes up in order to get the glucose out of the bloodstream and into the cells.
If we didn't have insulin or it wasn't functioning correctly, known as insulin resistance, blood glucose levels in
the blood would reach toxic levels.

In healthy people, this mechanism works very well and enables us to eat meals that are high in carbohydrates without our blood glucose levels becoming too high. However, this mechanism tends to break. Cells become resistant to the effects of insulin, which makes the pancreas have to secrete even more to drive the glucose into the cells. Basically, when you become insulin resistant, you will have more insulin in your blood all the time (until the entire thing breaks and leads to type II diabetes, which can happen eventually).

But insulin also has other functions. One of them is sending signals to our fat cells instructing them to pick up fat from the bloodstream, store it and to avoid burning the fat that they already carry. When insulin levels are chronically elevated, much of the energy in our bloodstream gets selectively deposited in the fat cells and stored.

Excess fructose consumption is a known cause of insulin resistance and elevated insulin levels in the blood by forcing the pancreas to constantly secrete more and more insulin and it eventually fatigues. When this happens, the body has a hard time accessing the stored fat and the brain starts to think that it is hungry. Then we eat more.

Mechanisms of sugar-induced fat gain.

Mechanism #1: Eating a lot of sugar chronically raises insulin levels in the blood, which selectively deposits energy from foods into fat cells. Fructose also causes weight gain by its effects on a hormone called leptin which is secreted by fat cells. The bigger the fat cells get, the more leptin they secrete. This is the signal your brain uses to determine how much fat it has stored for a rainy day. When we eat food, some of it gets stored in the fat cells. This makes the fat cells get bigger and

secrete more leptin. When the brain senses the increased leptin, it "sees" that we have enough fat stored and that we don't need to eat. This elegant mechanism is designed by nature to make us stop being hungry and eat less when there is plenty of fat in our fat cells, which is supposed to prevent us from becoming obese.

More fat = more leptin = we have enough energy = don't need to eat. Simple.

Increased leptin also makes us release more fat from our fat stores and raises the metabolic rate. This is how it's supposed to work, but if the brain becomes resistant to leptin (doesn't "see" the leptin in the blood) then this regulatory process won't work. If the brain doesn't see the leptin, it won't know that the fat cells are full and there won't be any signal to tell the brain that it needs to stop eating.

Low leptin = don't have enough energy stored = need to eat more and burn less.

This is how leptin resistance makes us fat. The brain thinks that the body is starving and makes us eat more and burn less. Trying to exert "willpower" over the powerful leptin-driven starvation signal is next to impossible. This is why most people can't just simply "eat less, move more" and live happily ever after. In order to be able to eat less, we have to get rid of the leptin resistance, so that our brain "sees" all the fat that we have stored. This is how excess sugar throws body fat regulation off, making the brain think that it needs to keep eating.

Mechanism #2: Fructose makes the brain leptin resistant, which means that the brain doesn't "see" all the stored fat in the body and thinks that it is starving. This causes a powerful leptin-induced biochemical drive to keep eating even when we don't need to. The way the body and brain regulate food intake is extremely complex and involves multiple hormones and neural circuits. There is a region in the brain called the hypothalamus, where all of these signals are interpreted. This is where leptin (discussed above) functions in the brain, along with various neurons and other hormones. Fructose continues to stimulate the hypothalamus and does not decrease appetite after consumption the way glucose does, which does diminish hypothalamic activity. This is why this added sugar, usually in the form of fructose, continues to stimulate rather than diminish appetite leading to weight gain.

Another important hormone is called *ghrelin*, the "hunger" hormone. The more ghrelin that is produced, the more hungry we feel. Another study showed that fructose did not reduce blood levels of ghrelin nearly as much as glucose did.

These studies suggest that fructose does not make you feel full after a meal in the same way as glucose, even with the exact same number of calories.

Mechanism #3: Fructose does not make you feel full after a meal in the same way as glucose, which leads to an increase in overall calorie intake. Sugar causes opiate and dopamine activity in the reward centers of the brain, just like drugs of abuse like cocaine. Intermittent access to sugar can lead to behavior and neurochemical changes that resemble the effects of a substance of abuse. The evidence is very strong for sugar being downright addictive. It makes perfect sense given that it affects the same neural pathways as drugs of abuse.

Eating sugar gives us "pleasure" and releases opiates and dopamine in the reward system of the brain, specifically in an area called the Nucleus Accumbens. These are the same areas stimulated by drugs of abuse like nicotine and cocaine. For certain individuals with a certain predisposition, this can lead to full blown addiction. Individuals that get strong cravings for sugar and are unable to quit or reduce their consumption despite negative physical consequences (such as weight gain) are sugar addicts.
Sugar, due to its powerful effects on the reward system in the brain, leads to classic signs of addiction comparable to drugs of abuse. This activates powerful reward-seeking behavior that can drive overeating.

1. Fructose causes insulin resistance and raises insulin levels in the body, which increases the deposition of fat in the fat cells.
2. Fructose causes resistance to a hormone called *leptin*, which makes the brain not "see" that the fat cells are full of fat. This leads to increased food intake and decreased fat burning.
3. Fructose does not make you feel full after meals. It does not lower levels of the hunger hormone *ghrelin* and it doesn't reduce blood flow in the centers of the brain that control appetite. This increases overall food intake.
4. Sugar, with its powerful effect on the reward system of the brain, causes addiction in certain individuals. This activates powerful reward-seeking behavior that also increases food intake.

So, excess fructose consumption dysregulates short-term energy balance on a meal-to-meal basis and throws long-term energy balance out of whack. The more sugar you eat and the longer this process is allowed to continue, the more powerful it becomes. Insulin and leptin resistance increase over time and the reward-seeking behavior becomes stronger. This way, sugar sets up an extremely powerful biochemical drive to make you eat more, burn less and get fat. Trying to exert willpower over this powerful drive can be next to impossible.

This does not apply to whole fruits, which are real foods with fiber and a low energy density. Fruits are a relatively minor source of fructose in the diet.

SUGAR AND DISEASE

1. Diabetes. Massive doses of sugar in the blood cause the pancreatic beta cells to constantly and furiously produce insulin to get the sugar out of the blood, where it causes toxic effects such as break apart various molecules, into the cells where it can be stored and used for energy. This constant bombardment causes the cells to become resistant to insulin in addition to the beta cells burning out leading to less and less produced insulin.
2. Obesity. The liver protects us by trying to reduce the level of sugar in the blood. Unfortunately, it does so through a process of lipogenesis in which it converts sugar into lipids (fats) leading to obesity. Leptin, the satiety hormone, becomes less effective in the oresents of high sugar levels. The sugar downregulates the leptin receptor making the hormone ineffective leading to increased eating.

3. Liver Metabolism. 20% of glucose but 100% of the fructose is metabolized by the liver. The glucose is quickly is used up as energy but the fructose leads to lipogenesis.
4. Sugar and Sex:
    a. Fructose and glucose in excess turn off genes which regulate levels of active testosterone and estrogen in the body.
    b. Excessive fat in the diet and in the body causes your liver to turn off production of sex hormone binding globulin. This leads to less hormone available in the body resulting in a slew of adverse side effects in both men and women.
    c. Glucose tolerance tests showed that testosterone levels were decreased in both men and women and increase vaginal dryness in women.
5. Sugar and violence:
    . hypoglycemia (which is the crash that occurs after a significant sugar load leading to an insulin rush) leads to a variety of side effects and behavioral changes like:
        i. Increased aggressiveness
        ii. Confusion and Irritability
        iii. Blurred vision
        iv. Manic behavior
        v. Attention Deficit Disorder
    a. Increased sugar levels lead to production of counter regulatory fight-or-flight hormones.
    b. In studies of prison inmates, there was a 27% greater risk of violent behaviour if there was daily consumption of high sugar products.

Bone Density. Cola drinkers have lower bone density. This is because the high amount of phosphorus in the soda which inhibits calcium absorption. However, the phosphoric acid in cola also causes a release of calcium out of your bones. The alkaline calcium helps to buffer the acidic phosphoric acid in the blood. The caffeine in soda is not a direct problem but in the environment of high acidity, there is an amplified effect of losing calcium resulting in bone loss. In addition, it is a nervous system stimulant.

Obesity. Independent studies find that there is a direct correlation between obesity and sugar-sweetened beverage. By the way, studies funded by the soda companies did not find such a connection. Big surprise.

Diabetes. 1-2 sodas a day is correlated with a 26% risk of developing type 2 diabetes. It also significantly increases the risk for insulin resistance, metabolic syndrome and cardiovascular disease. The massive amounts of sugar, there is a tremendous surge in sugar (77 grams in the case of Mountain Dew) leading to a massive release of insulin from the pancreas. That much sugar in your blood is dangerous so the body tried to push it into the cells, hence the insulin release. Over time, the insulin become resistant and does not work as well (insulin resistance). Once the cells are filled, the muscles then fill up with glycogen and then the liver gets involved converting the sugar into glycogen for storage. As the liver gets saturated, the process of lipogenesis (new fat formation) begins.