

Elementary School Student Learns About Fat Molecules With Help From Rush

Gabriel Paner is an eighth grade student at Mark T. Skinner West Elementary School, located near Rush University Medical Center. He loves chemistry and is interested in pursuing career in science. Rasa Kazlauskaitė, MD, MS, MSc, has been a mentor to Gabriel. His inquisitive nature, led him to learn how more about fat and weight loss. Below is a scientific investigation from Gabriel, which he volunteered to do conduct under the mentorship of Kazlauskaitė.

“This was was a great learning experience for Gabe,” says Kazlauskaitė. “He had to demystify how fat molecules are broken down and what it means practically to a person losing weight.”

HOW FAT GETS ELIMINATED WHEN PEOPLE LOSE WEIGHT?

By Gabriel Paner

Most people aspire to or lose weight at some point in their lives. What way does fat get eliminated from the body when people lose weight?

THE SURVEY

Gabe Paner asked 47 doctors, three teachers, and six middle school students how fat gets eliminated from the body when people lose weight. Most frequent responses were that fat “turns into energy,” “it burns,” “it shrinks”, or “gets metabolized to byproducts and/or waste.” Some responders thought that “it turns into glucose,” “it is breathed out into the air as carbon dioxide or water, and disposed of in urine or sweat.” Our data highlights that most people have a vague understanding that burning fat produces energy and byproducts, but the details of this process are hidden in the fog. These answers inspired Gabriel Paner to dig deeper and search for the answers.

THE EXPLANATION

The **first** step in explanation relates to the Law of Conservation of Mass: that matter can only turn into other matter; the matter cannot turn into energy. The mass of fat at the beginning of a reaction will equal the mass of the end-products of fat “burning” that will have to be eliminated in order to “lose” the byproducts, and thus – to lose the fat.

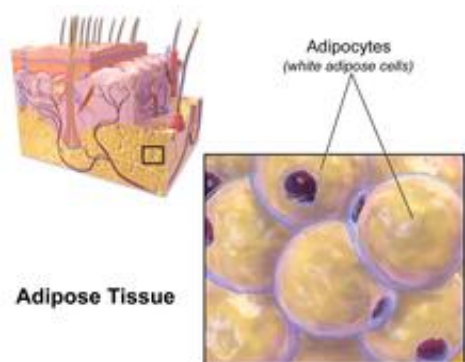


FIGURE 1. Adipose (fat) tissue and adipocytes. Adapted from: Blausen.com staff (2014). "[Medical gallery of Blausen Medical 2014](#)". WikiJournal of Medicine 1 (2). [DOI: 10.15347/wjm/2014.010](#). ISSN 2002-4436.

The **second** step is to understand the nature of fat “burning” end-products that must be eliminated. Human fat is stored in adipose tissue cells called adipocytes (**Figure 1**). The actual fat molecules are triglycerides, which combine glycerol with three fatty acids. Chemically speaking, an average triglyceride molecule can be expressed as C₅₅H₁₀₄O₆. The most common fatty acids in the human body are oleate, palmitate, and linoleate.

When fat is broken down, we say “fat is burned” because it literally burns (don’t worry, I’m sure we’re fireproof). Oxygen oxidizes fat molecules through multiple biochemical steps to final end-products - carbon dioxide (CO₂) and water (H₂O). In this process, fat molecules don’t turn into energy; the chemical reactions release energy since the fundamental law of conservation of mass is that matter can only turn into other matter.

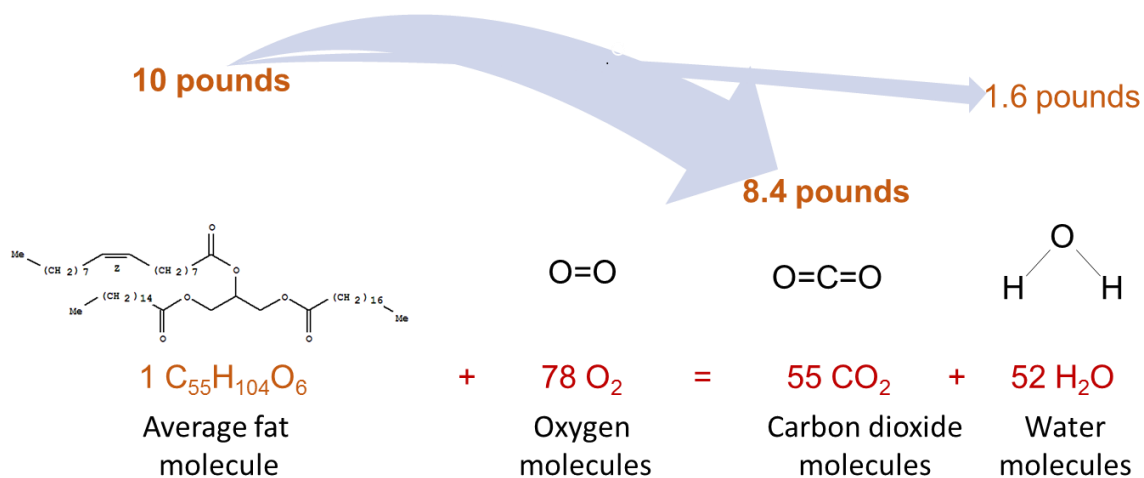


FIGURE 2. 10 pounds of fat “burns” to 8.4 pounds of carbon dioxide.

For example, to burn 10 pounds of fat, you will need to use 29 pounds of oxygen, producing 28 pounds of carbon dioxide and 11 pounds of water (**Figure 2**) and also, burning 10 pounds of fat releases approximately 35,000 kcal of energy. Energy will be released during this process, but it is not made of these fat molecules. Carbon dioxide

will be breathed out into the air through your lungs, while the water will be excreted out as urine or sweat.

If you have a hard time imagining what this means, we did some fun math for you. An average person exhales approximately 2.3 pounds of carbon dioxide over the day. If the 10 pounds are lost over an average of 28 days, 64.4 pounds with “fat-burning” of 8.4 pounds extra effort will constitute 72.8 pounds of carbon dioxide over 28 days. As exhaled air has 4% carbon dioxide, and each pound of room-temperature carbon dioxide has a volume of 8.7 cubic feet, the person will exhale 15,822 cubic feet of air. Well, that means that a person losing 10 pounds of fat can inflate 113 birthday balloons every day for 28 days. Since a cup of water is half a pound, you could fill up 22 cups of water by burning ten pounds of fat. If you don’t know what to do with this much energy released, you can bike from Chicago all the way to Philadelphia. Since cycling ten miles burns about 550 kcal, and burning ten pounds releases 35,000 kcal, it will give enough energy to bike 664 miles from Chicago to Philadelphia.

However, breathing faster (hyperventilating) isn’t the solution to losing weight. Hyperventilating will release more carbon dioxide but will not increase its production rate. Hyperventilation will only make you dizzy. Things that help you burn fat and increase production of CO₂ are exercise, eating less, or choosing whole foods over processed foods, which may contain preservatives that slow-down metabolism. Certain hormones can increase metabolism, like growth hormones produced while sleeping. Therefore getting a good night's sleep is essential when losing weight.

THE CONCLUSION

It is easier to prevent weight gain than to lose weight. Make sure you move a lot, get your exercise, choose whole foods, get a good night's sleep, stay calm and keep breathing.