



## Sugar, Metabolism and Human Health

Studies emerging from the school's Department of Molecular Biosciences are helping the health profession understand and identify strategies for preventing and treating type 2 diabetes, which affects more than 21 million people in the United States. Diabetes results in more than \$150 billion in direct and indirect annual costs. School of Veterinary Medicine research sheds light on the development of cardiovascular disease, particularly in overweight individuals.

**The fructose difference**—Molecular biologists investigating how different sweeteners affect the metabolism concluded that consuming fructose-sweetened beverages increases blood levels of unfavorable fats and increases fat inside the abdomen, considered more dangerous than subcutaneous fat. The scientists also observed that overconsumption of fructose-sweetened drinks decreases insulin sensitivity in overweight and obese humans. Such changes in how the body handles fats create medical conditions that increase the chances of heart attack and stroke. The changes did not take place, however, when subjects consumed drinks sweetened with glucose.

**Impacts on insulin resistance**—In their study of sweetened beverages, veterinary scientists reported that overconsumption of fructose, but not glucose, may contribute to the development of metabolic syndrome by increasing circulating uric acid, altering liver function, and producing more of the RBP-4 protein—all of which are associated with insulin resistance.

**Too much sugar**—The molecular biosciences team discovered that adults who consume lots of sugar face significantly higher risks of heart disease. In a short-term study, participants consuming fructose or high-fructose corn syrup exhibited increased bloodstream concentrations of three known risk factors for heart disease: LDL cholesterol, triglycerides, and a protein known as apolipoprotein-B, which can lead to plaque buildup in arteries. Federal Dietary Guidelines for Americans suggest that people consume no more than 25 percent of daily calories as added sugar. Based on the veterinary study, the authors state that U.S. dietary guidelines for sugar should be reconsidered.

**Leptin lowers blood sugar**—In 2011, school researchers demonstrated for the first time that twice-daily injections of the hormone leptin lower blood sugar levels and circulating triglycerides in an animal model with type 2 diabetes. The findings suggest that leptin, known to play an important role in regulating appetite and fat metabolism, may prove successful in treating the most common form of diabetes.

**Heart of the matter**—Veterinary researchers found that hyperamylinemia, a condition common in patients with obesity and insulin resistance, promotes amylin deposition in the heart. They learned that additional amylin caused alterations of cardiac myocyte structure and function. Results suggest that detection and disruption of amylin buildup in the heart may help physicians predict some heart problems in diabetics and provide a novel therapeutic strategy to address diabetic cardiomyopathy.

**Surgery delays onset of diabetes**—In 2010 a team led by an endocrinologist based at the school showed for the first time that a surgical procedure similar to weight-loss surgery in humans can delay the onset of type 2 diabetes.

Investigators also identified biochemical changes caused by the surgeries that may be responsible for that delay. Findings from the study will aid medical professionals to identify new strategies for preventing and treating type 2 diabetes.

Significant health changes—Subjects in the above-mentioned surgical study had:

- Lower fluctuations in blood sugar levels
- Improved insulin production, making them better able to metabolize sugar
- Decreased levels of lipids (cholesterol and triglyceride) in the bloodstream, known to be risk factors for cardiovascular disease in humans
- Increased production of bile acids (involved in fat metabolism) and greater production of the hormone that improves insulin secretion and insulin sensitivity

Citations—The 2009 publication, "Consuming fructose-sweetened, not glucose-sweetened, beverages increases visceral adiposity and lipids and decreases insulin sensitivity in overweight/obese humans," is one of the three most accessed clinical papers published by the *Journal of Clinical Investigation* in the last five years.

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