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## Cancer Cells Preferentially use Sugars. References

by Patrick Quillin, PHD, RD, CNS♦from the book ♦Beating Cancer with Nutrition♦

Highly recommended reading.

During the last 10 years I have worked with more than 500 cancer patients as director of nutrition for Cancer Treatment Centers of America in Tulsa, Okla. It puzzles me why the simple concept "sugar feeds cancer" can be so dramatically overlooked as part of a

Of the 4 million cancer patients being treated in America today, hardly any are offered any scientifically guided nutrition therapy beyond being told to "just eat good foods." Most patients I work with arrive with a complete lack of nutritional advice. I believe many cancer patients would have a major improvement in their outcome if they controlled the supply of cancer's preferred fuel, glucose. By slowing the cancer's growth, patients allow their immune systems and medical debulking therapies--chemotherapy, radiation and surgery to reduce the bulk of the tumor mass--to catch up to the disease. Controlling one's blood-glucose levels through diet, supplements, exercise, meditation and prescription drugs when necessary can be one of the most crucial components to a cancer recovery program. The sound bite--sugar feeds cancer--is simple. The explanation is a little more complex.

The 1931 Nobel laureate in medicine, German Otto Warburg, Ph.D., first discovered that cancer cells have a fundamentally different energy metabolism compared to healthy

cells. The crux of his Nobel thesis was that malignant tumors frequently exhibit an increase in anaerobic glycolysis--a process whereby glucose is used as a fuel by cancer cells with lactic acid as an anaerobic byproduct--compared to normal tissues.<sup>1</sup> The large amount of lactic acid produced by this fermentation of glucose from cancer cells is then transported to the liver. This conversion of glucose to lactate generates a lower, more acidic pH in cancerous tissues as well as overall physical fatigue from lactic acid buildup.<sup>2,3</sup> Thus, larger tumors tend to exhibit a more acidic pH.<sup>4</sup>

This inefficient pathway for energy metabolism yields only 2 moles of adenosine triphosphate (ATP) energy per mole of glucose, compared to 38 moles of ATP in the complete aerobic oxidation of glucose. By extracting only about 5 percent (2 vs. 38 moles of ATP) of the available energy in the food supply and the body's calorie stores, the

cancer is "wasting" energy, and the patient becomes tired and undernourished. This vicious cycle increases body wasting.<sup>5</sup> It is one reason why 40 percent of cancer patients die from malnutrition, or cachexia.<sup>6</sup>

Hence, cancer therapies should encompass regulating blood-glucose levels via diet, supplements, non-oral solutions for cachectic patients who lose their appetite, medication, exercise, gradual weight loss and stress reduction. Professional guidance and patient self-discipline are crucial at this point in the cancer process. The quest is not to eliminate sugars or carbohydrates from the diet but rather to control blood glucose within a narrow range to help starve the cancer and bolster immune function.

The glycemic index is a measure of how a given food affects blood-glucose levels, with each food assigned a numbered rating. The lower the rating, the slower the digestion and absorption process, which provides a healthier, more gradual infusion of sugars into the bloodstream. Conversely, a high rating means blood-glucose levels are increased quickly, which stimulates the pancreas to secrete insulin to drop blood-sugar levels. This rapid fluctuation of blood-sugar levels is unhealthy because of the stress it places on the body (see glycemic index chart, p. 166).

### Sugar in the Body and Diet

Sugar is a generic term used to identify simple carbohydrates, which includes monosaccharides such as fructose, glucose and galactose; and disaccharides such as maltose and sucrose (white table sugar). Think of these sugars as different-shaped bricks in a wall. When fructose is the primary monosaccharide brick in the wall, the glycemic index registers as healthier, since this simple sugar is slowly absorbed in the gut, then converted to glucose in the liver. This makes for "time-release foods," which offer a more gradual rise and fall in blood-glucose levels. If glucose is the primary monosaccharide brick in the wall, the glycemic index will be higher and less healthy for the individual. As the brick wall is torn apart in digestion, the glucose is pumped across the intestinal wall directly into the bloodstream, rapidly raising blood-glucose levels. In other words, there is a "window of efficacy" for glucose in the blood: levels too low make one feel lethargic and can create clinical hypoglycemia; levels too high start creating the rippling effect of diabetic health problems.

The 1997 American Diabetes Association blood-glucose standards consider 126 mg

glucose/dL blood or greater to be diabetic; 111125 mg/dL is impaired glucose tolerance and less than 110 mg/dL is considered normal. Meanwhile, the Paleolithic diet of our ancestors, which consisted of lean meats, vegetables and small amounts of whole grains, nuts, seeds and fruits, is estimated to have generated blood glucose levels between 60 and 90 mg/dL.<sup>7</sup> Obviously, today's high-sugar diets are having unhealthy effects as far as blood-sugar is concerned. Excess blood glucose may initiate yeast overgrowth, blood vessel deterioration, heart disease and other health conditions.<sup>8</sup>

Understanding and using the glycemic index is an important aspect of diet modification for cancer patients. However, there is also evidence that sugars may feed cancer more

efficiently than starches (comprised of long chains of simple sugars), making the index slightly misleading. A study of rats fed diets with equal calories from sugars and starches, for example, found the animals on the high-sugar diet developed more cases of breast cancer.<sup>9</sup> The glycemic index is a useful tool in guiding the cancer patient toward a healthier diet, but it is not infallible. By using the glycemic index alone, one could be led to thinking a cup of white sugar is healthier than a baked potato. This is because the glycemic index rating of a sugary food may be lower than that of a starchy food. To be safe, I recommend less fruit, more vegetables, and little to no refined sugars in the diet of cancer patients.

### What the Literature Says

A mouse model of human breast cancer demonstrated that tumors are sensitive to blood-

glucose levels. Sixty-eight mice were injected with an aggressive strain of breast cancer, then fed diets to induce either high blood-sugar (hyperglycemia), normoglycemia or low blood-sugar (hypoglycemia). There was a dose-dependent response in which the lower the blood glucose, the greater the survival rate. After 70 days, 8 of 24 hyperglycemic mice survived compared to 16 of 24 normoglycemic and 19 of 20 hypoglycemic.<sup>10</sup> This suggests that regulating sugar intake is key to slowing breast tumor growth (see chart, p. 164).

In a human study, 10 healthy people were assessed for fasting blood-glucose levels and the phagocytic index of neutrophils, which measures immune-cell ability to envelop and destroy invaders such as cancer. Eating 100 g carbohydrates from glucose, sucrose, honey and orange juice all significantly decreased the capacity of neutrophils to engulf bacteria. Starch did not have this effect.<sup>11</sup>

A four-year study at the National Institute of Public Health and Environmental Protection in the Netherlands compared 111 biliary tract cancer patients with 480 controls. Cancer risk associated with the intake of sugars, independent of other energy sources, more than doubled for the cancer patients.<sup>12</sup> Furthermore, an epidemiological study in 21 modern countries that keep track of morbidity and mortality (Europe, North America, Japan and others) revealed that sugar intake is a strong risk factor that contributes to higher breast cancer rates, particularly in older women.<sup>13</sup>

Limiting sugar consumption may not be the only line of defense. In fact, an interesting botanical extract from the avocado plant (*Persea americana*) is showing promise as a new cancer adjunct. When a purified avocado extract called mannoheptulose was added to a

number of tumor cell lines tested in vitro by researchers in the Department of Biochemistry at Oxford University in Britain, they found it inhibited tumor cell glucose uptake by 25 to 75 percent, and it inhibited the enzyme glucokinase responsible for glycolysis. It also inhibited the growth rate of the cultured tumor cell lines. The same researchers gave lab animals a 1.7 mg/g body weight dose of mannoheptulose for five days; it reduced tumors by 65 to 79 percent.<sup>14</sup> Based on these studies, there is good reason to believe that avocado extract could help cancer patients by limiting glucose to the tumor cells.

Since cancer cells derive most of their energy from anaerobic glycolysis, Joseph Gold, M.D., director of the Syracuse (N.Y.) Cancer Research Institute and former U.S. Air Force research physician, surmised that a chemical called hydrazine sulfate, used in rocket fuel, could inhibit the excessive gluconeogenesis (making sugar from amino acids) that occurs in cachectic cancer patients. Gold's work demonstrated hydrazine sulfate's ability to slow and reverse cachexia in advanced cancer patients. A placebo-controlled trial followed 101 cancer patients taking either 6 mg hydrazine sulfate three times/day or placebo. After one month, 83 percent of hydrazine sulfate patients increased their weight, compared to 53 percent on placebo.<sup>15</sup> A similar study by the same principal researchers, partly funded by the National Cancer Institute in Bethesda, Md., followed 65 patients. Those who took hydrazine sulfate and were in good physical condition before the study began lived an average of 17 weeks longer.<sup>16</sup>

In 1990, I called the major cancer hospitals in the country looking for some information on the crucial role of total parenteral nutrition (TPN) in cancer patients. Some 40 percent

of cancer patients die from cachexia.<sup>5</sup> Yet many starving cancer patients are offered either no nutritional support or the standard TPN solution developed for intensive care units. The solution provides 70 percent of the calories going into the bloodstream in the form of glucose. All too often, I believe, these high-glucose solutions for cachectic cancer patients do not help as much as would TPN solutions with lower levels of glucose and higher levels of amino acids and lipids. These solutions would allow the patient to build strength and would not feed the tumor.<sup>17</sup>

The medical establishment may be missing the connection between sugar and its role in tumorigenesis. Consider the million-dollar positive emission tomography device, or PET scan, regarded as one of the ultimate cancer-detection tools. PET scans use radioactively labeled glucose to detect sugar-hungry tumor cells. PET scans are used to plot the progress of cancer patients and to assess whether present protocols are effective.<sup>18</sup>

In Europe, the "sugar feeds cancer" concept is so well accepted that oncologists, or cancer doctors, use the Systemic Cancer Multistep Therapy (SCMT) protocol. Conceived by Manfred von Ardenne in Germany in 1965, SCMT entails injecting patients with glucose to increase blood-glucose concentrations. This lowers pH values in cancer tissues via lactic acid formation. In turn, this intensifies the thermal sensitivity of the malignant tumors and also induces rapid growth of the cancer. Patients are then given whole-body hyperthermia (42 C core temperature) to further stress the cancer cells, followed by chemotherapy or radiation.<sup>19</sup> SCMT was tested on 103 patients with metastasized cancer or recurrent primary tumors in a clinical phase-I study at the Von Ardenne Institute of Applied Medical Research in Dresden, Germany. Five-year survival rates in SCMT-treated patients increased by 25 to 50 percent, and the complete rate of

tumor regression increased by 30 to 50 percent.<sup>20</sup> The protocol induces rapid growth of the cancer, then treats the tumor with toxic therapies for a dramatic improvement in outcome.

The irrefutable role of glucose in the growth and metastasis of cancer cells can enhance many therapies. Some of these include diets designed with the glycemic index in mind to

regulate increases in blood glucose, hence selectively starving the cancer cells; low-glucose TPN solutions; avocado extract to inhibit glucose uptake in cancer cells; hydrazine sulfate to inhibit gluconeogenesis in cancer cells; and SCMT.

A female patient in her 50s, with lung cancer, came to our clinic, having been given a death sentence by her Florida oncologist. She was cooperative and understood the connection between nutrition and cancer. She changed her diet considerably, leaving out 90 percent of the sugar she used to eat. She found that wheat bread and oat cereal now had their own wild sweetness, even without added sugar. With appropriately restrained medical therapy--including high-dose radiation targeted to tumor sites and fractionated chemotherapy, a technique that distributes the normal one large weekly chemo dose into a 60-hour infusion lasting days--a good attitude and an optimal nutrition program, she beat her terminal lung cancer. I saw her the other day, five years later and still disease-free, probably looking better than the doctor who told her there was no hope.

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