Understanding Carbohydrates

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Objectives

- Understand what carbohydrates are and the role they play in our body.
- Address the question “Does sugar feed cancer?”
- Understand how to make diet changes for optimal glucose control.
The Dilemma

- Common Questions:
  - How do I eat better?
  - Is there a diet that I should follow?

- You may have heard conflicting messages:
  - Internet sites and books warning that sugar feeds cancer.
  - You may have been told to eat whatever you want to maintain your weight.

= STRESS
Big Picture Puzzle

- What are the correct percentages of Protein, Carbohydrate and Fat?
- Confusion with:
  - low fat diets
  - low carbohydrate diets
  - high protein diets
  - high fat diets

Food Guide Pyramid ...

*Is this what we should be looking at?*
Carbohydrates...

begin with photosynthesis and transform energy from sunlight into sugars
Photosynthesis

Energy -> Carbon Dioxide (Chlorophyll) -> Glucose (Water) 

Oxygen is released
Glucose is formed
Simple Carbohydrates

Monosaccharides:
- Fructose
- Glucose
- Galactose

Disaccharides:
- Sucrose
- Lactose
- Maltose
Simple Carbohydrates

Examples of simple carbohydrates:

- Table sugar (sucrose)
- Honey
- Agave nectar
Complex Carbohydrates

- Polysaccharides - made up of many of simple carbohydrates
- Oligosaccharides - 2-10 monosaccharides

Most whole plant foods have a small amount of mono or disaccharides but mainly polysaccharides
Polysaccharides

Polysaccharides include whole grains, legumes
Oligosaccarides

Oligosaccarides include fructo-oligosaccharides or FOS

Fructo-oligosaccharides like inulin work as a “prebiotic” or fuel source for good bacteria in the large intestine.

These include:
- Onions
- Garlic
- Jerusalem artichoke
Resistant Starch

Acts more like a fiber than a starch

Fermentation promotes generation of Short Chain Fatty Acids (SCFA) by bacteria

Short chain fatty acids play an important role in gut health. They also have anti-inflammatory properties, induce apoptosis and inhibit angiogenesis.

Examples: lentils, barley, oatmeal, black beans, peanuts, peas potatoes, yams, cucumbers, apple, bananas
Fiber: the Undigested Part of the Plant

Soluble
- Decreases cholesterol
- Delays absorption of glucose
- Increases satiety

Insoluble
- Adds weight and volume to stools
- Prevents constipation
- Increases transit time
Dietary guidelines for Americans recommend 25 grams fiber daily.

The average American gets in less than 10 grams daily of dietary fiber.

Worldwide, average fiber intake is 50-75 grams daily.

Measuring fiber intake is one of best ways to evaluate for diet quality.
Fiber

Diets high in fiber decrease risk of colorectal cancer

“Fiber exerts several effects in the gastrointestinal tract, but the precise mechanisms for its probable protective role are still not clearly understood. Fiber dilutes fecal content, decreases transit time, and increases stool weight. The gut flora form a wide range of dietary carbohydrates and mucins that reach the colon produces fermentation products, especially short-chain fatty acids. Short-chain fatty acids, such as butyrate, induce apoptosis, cell cycle arrest, and differentiation in experimental studies.”

Expert Report/Continuous Update Project WCRF/AICR 2011
Big Picture Puzzle: 
Is This What We Should Be Looking At?

Your cells
...need more than just fuel, or glucose (from food) to keep working.

- Essential fatty acids
- Minerals
- Vitamins
- Phytonutrients
Refined Carbohydrates

- Lack the nutrients and fiber needed to keep our bodies working optimally.
- Higher amounts of fructose and glucose for a sweeter taste.
- Digest quickly, increasing blood glucose and insulin levels.
But, Does Sugar Feed Cancer?

- Glucose, or sugar, is used by every cell in your body.

- It is so important, your body can convert protein and fat into glucose for your brain.

- It is possibly the relationship of sugar to higher insulin levels and related growth factors that may influence cancer cell growth.
Sugar and Cancer

When we eat foods with carbohydrates, they are broken down to simple sugars in the intestine where they are absorbed into the blood, increasing our blood glucose levels.

In response, our pancreas releases insulin which

- Signals glucose to enter the cell through insulin receptors on the cell
- Increase storage of calories as fat. If levels of insulin are high, this signals the body there’s plenty of food for now.
Sugar and Cancer
What About Insulin?

High blood sugars $\rightarrow$ More Insulin

- Consistently elevated insulin levels:
  - Increase insulin like growth factors (IGF-1) and binding proteins
  - Increases inflammatory hormones
  - Suppresses immune function
  - Both insulin and IGF-1 inhibit apoptosis (normal cell death)
Insulin Resistance and Breast Cancer

HEAL Study

- 527 women with Stages I-III breast cancer
  - ↑ breast cancer mortality with
    - Elevated HOMA scores
      - HOMO = homeostatic model assessment score
      - A marker for insulin resistance and long term hyperinsulinemia
    - Low levels of adiponectin

Duggan, J Clin Oncol 29:32-39; 2010
Insulin Resistance

When insulin receptors work poorly, more insulin is released to compensate.

Risk factors for insulin resistance include:

- Genetic susceptibility
- Inactivity
- Obesity - especially central weight obesity
- Consistently high blood sugar levels
Insulin Resistance

Epidemic

- 5% of children
- 34% of adults over age 20
- 51% of people over age 60

National Health Statistics Report. CDC, No 13, May 2009
Signs of Insulin Resistance

- Weight gain (apple vs pear shape)
- Fatigue
- Feeling tired after a meal
- Harder time losing weight
- Cravings for foods
- Hot flashes
- Energy swings
- Low blood sugar - signs of hypoglycemia
- Impaired glucose tolerance - fasting blood sugar >100 or high insulin
Metabolic Syndrome

- Phrase used to describe the group of symptoms linked to insulin resistance.
  - A person is considered to have metabolic syndrome if they have three or more of the following symptoms:
    - Waist circumference of >40 inches in men or 35 inches in women
    - Fasting glucose >110 mg/dl
    - Blood pressure >130/85
    - Triglycerides >150 mg/dL
    - Low HDL (<40 mg/dL for men and <50 mg/dL for women)
Metabolic Syndrome

Metabolic syndrome and Breast Cancer Recurrence

- 110 postmenopausal breast cancer patients followed for 5.5 years
- Metabolic syndrome at baseline was a prognostic factor for recurrence - 2.4%

How Can the Foods I Eat Help?

- New American Plate- AICR
- Glycemic index/load
- Goals around attaining adequate plant foods.
New American Plate

- Not a diet and does not require calculations
- Based on evidence from *Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective* and evidence that a diet high in plant foods may reduce the risk of cancer
- Healthy portion sizes - Serving Size Finder
- New American Plate Challenge - 12 Weeks to a Healthier You
  - One weekly eat smart or move more challenge for 12 weeks
  - Weekly emails to help keep you motivated along the way
  - Tips, tools, recipes and more to help you succeed
  - Support from the Challenge community and AICR dietitians
Glycemic Load and Glycemic Index

- Glucose control is usually maintained with carbohydrate portions - either measuring grams or carbohydrate choices allowed at meals/snacks.

- In the early 1980’s, researchers found that certain carbohydrate rich foods increased glucose levels in the blood faster and higher than others.

- Glycemic index measures the effect of a particular carbohydrate on blood sugar level. The higher the number, the greater the rise in blood glucose. Pure glucose is used as a reference and given a GI of 100.
Blood Glucose Concentrations After Ingesting High and Low Glycemic Index Foods

*containing 50 g glucose

Adapted from: Anderson et al. Modern Nutrition in Health and Disease; 2001: 1269.
Glycemic Load = GL (Quality x Quantity)

Glycemic load *takes serving size into account*

- **It tests a normal serving size**
  - Multiplies GI by the grams of carbohydrate in a normal serving
  - \(<10 = \text{low}; 10 - 20 = \text{moderate}, > 20 = \text{high}\)

- **May be lower than the GI**, especially for foods with smaller servings, or low carbohydrate content
## Glycemic Index vs. Glycemic Load

<table>
<thead>
<tr>
<th>Food</th>
<th>Glycemic Index (GI)</th>
<th>Glycemic Load (GL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White rice</td>
<td>&lt;=55</td>
<td>&lt;=10</td>
</tr>
<tr>
<td>Brown rice</td>
<td>56-69</td>
<td>11-19</td>
</tr>
<tr>
<td>Bananas</td>
<td>&gt;=70</td>
<td>&gt;=20</td>
</tr>
<tr>
<td>Watermelon</td>
<td>72</td>
<td>4</td>
</tr>
<tr>
<td>Red lentils</td>
<td>26</td>
<td>5</td>
</tr>
<tr>
<td>Milk</td>
<td>32</td>
<td>4</td>
</tr>
<tr>
<td>Popcorn</td>
<td>72</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Food</th>
<th>GI</th>
<th>GL</th>
</tr>
</thead>
<tbody>
<tr>
<td>White rice</td>
<td>79</td>
<td>40</td>
</tr>
<tr>
<td>Brown rice</td>
<td>55</td>
<td>18</td>
</tr>
<tr>
<td>Bananas</td>
<td>51</td>
<td>13</td>
</tr>
<tr>
<td>Watermelon</td>
<td>72</td>
<td>4</td>
</tr>
<tr>
<td>Red lentils</td>
<td>26</td>
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<td>Popcorn</td>
<td>72</td>
<td>8</td>
</tr>
</tbody>
</table>
## Low Glycemic Substitutions

<table>
<thead>
<tr>
<th>Instead of this...</th>
<th>Try this...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food</strong> (1 cup serving)</td>
<td><strong>Glycemic Load</strong></td>
</tr>
<tr>
<td>White Flour</td>
<td>76</td>
</tr>
<tr>
<td>Whole Wheat Flour</td>
<td>44</td>
</tr>
<tr>
<td>Corn, sweet yellow</td>
<td>35</td>
</tr>
<tr>
<td>Hamburger Bun</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown rice</td>
<td>22</td>
</tr>
<tr>
<td>Pasta noodles</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Mashed Potatoes</td>
<td>16</td>
</tr>
</tbody>
</table>
Glycemic Load

High glycemic load increases risk of endometrial cancer

Long-term consumption of a high glycemic load diet results in hyperinsulinemia, which in turn increases the bioavailability of insulin-like growth factor 1 (IGF-1) and directly promotes cell growth, reduces cell death and stimulates cell division in endometrial cancer cell lines. Insulin and IGF-1 are also powerful negative regulators of sex hormone-binding globulin synthesis in vitro and may therefore stimulate endometrial cancer. High glycemic load diets may also influence the risk of endometrial cancer by increasing oxidative stress.

Expert Report/Continuous Update Project WCRF/AICR 2013
What Else Effects Glucose Levels?

- STRESS
- Weight - especially weight around the waist
- Exercise
Setting Goals

Whole plant foods:
- Maximize phytonutrients
- Increase fiber
- Decrease calories
- Increase satiety

Each day aim for:
- 3 cups non-starchy vegetables
- 1.5 cups fruit
- Use culinary herbs and spices
Sugar and Endometrial Cancer

- Higher intake of sugar sweetened beverages and sugar associated with an increased risk of endometrial cancer.
  - 23,039 postmenopausal women in the Iowa Women’s Health Study followed between 1986-2010
  - Risk was 78% higher among women with highest SSB intake
  - Increased risk observed independent of BMI, physical activity, history of diabetes or smoking.

Inoue-Choi, Cancer Epidemiol Biomarkers Prev, 2384-2394; 2013
Sugar and Endometrial Cancer

- Consumption of sugary foods and drinks and risk of endometrial cancer.
  - EDGE study, 424 cases and 398 controls with mean age of 63.4
  - Women who had the highest intake of added sugar had an increased risk of endometrial cancer

King, et al, Cancer Causes Control, 1427-1436; 2013
Sugar

- The World Health Organization guidelines on sugar limits to less than 5% calories
  - Approximately 25 grams or 6 teaspoons daily
  - One soda is approximately 40 grams

- It is estimated that the average American consumes between 100-150 grams of sugar a day.

Sugar
Read labels: other words for added sweeteners...

- Brown rice syrup
- Corn sweetener
- Corn syrup
- Cane juice
- Dehydrated cane juice
- Dextrin
- Dextrose
- Fructose
- Fruit juice concentrate
- Glucose
- High fructose corn syrup
- Honey
- Invert sugar
- Lactose
- Maltodextrin
- Maple syrup

- Malt syrup
- Maltose
- Mannitol
- Maple syrup
- Maltose
- Molasses
- Raw sugar
- Rice syrup
- Sorbitol
- Sorghum syrup
- Sucrose
- Syrup
- Treacle
- Trebinado sugar
- Xylose
### Original Label

**Nutrition Facts**  
Serving Size: 2/3 cup (85g)  
Servings Per Container: About 8

<table>
<thead>
<tr>
<th>Amount Per Serving</th>
<th>Calories 200</th>
<th>Calories from Fat 72%</th>
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</thead>
<tbody>
<tr>
<td>Total Fat</td>
<td>8g</td>
<td>12%</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>1g</td>
<td>6%</td>
</tr>
<tr>
<td>Trans Fat</td>
<td>0g</td>
<td></td>
</tr>
<tr>
<td>Cholesterol</td>
<td>0mg</td>
<td>0%</td>
</tr>
<tr>
<td>Sodium</td>
<td>140mg</td>
<td>7%</td>
</tr>
<tr>
<td>Total Carbohydrate</td>
<td>37g</td>
<td>12%</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>4g</td>
<td>16%</td>
</tr>
<tr>
<td>Sugars</td>
<td>1g</td>
<td></td>
</tr>
<tr>
<td>Protein</td>
<td>3g</td>
<td></td>
</tr>
</tbody>
</table>

- *Percent Daily Values are based on a 2,000 calorie diet.  
  Your daily values may be higher or lower depending on your calorie needs.

**Vitamins**

- **Vitamin A**: 10%  
- **Vitamin C**: 6%  
- **Calcium**: 20%  
- **Iron**: 45%

**New Label**

**Nutrition Facts**  
Serving Size: 2/3 cup (85g)

<table>
<thead>
<tr>
<th>Amount per serving</th>
<th>Calories 230</th>
<th>% Daily Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Fat</td>
<td>8g</td>
<td>12%</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>1g</td>
<td>5%</td>
</tr>
<tr>
<td>Trans Fat</td>
<td>0g</td>
<td></td>
</tr>
<tr>
<td>Cholesterol</td>
<td>0mg</td>
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</tr>
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<td>27g</td>
<td>10%</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>4g</td>
<td></td>
</tr>
<tr>
<td>Total Sugars</td>
<td>1g</td>
<td></td>
</tr>
<tr>
<td>Includes 1g Added Sugars</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein</td>
<td>3g</td>
<td></td>
</tr>
</tbody>
</table>

**Vitamins**

- **Vitamin D**: 10%  
- **Calcium**: 20%  
- **Iron**: 45%  
- **Potassium**: 10%  

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

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[Image of the nutrition label]
Fructose

- Intake has dramatically increased over the past 30 years
- Main form in the American diet is high-fructose corn syrup in soft drinks and processed foods
- Increases release of inflammatory factors in the liver
- High levels are associated with fatty liver
- Impairs insulin signaling - independent from increase in energy intake
Ketogenic Diets

- Used since the 1920’s to treat seizure disorders. Administered in this setting under the care of a neurologist and registered dietitian. Diet is long term to help control seizures.

- Structured meal plan with meals individualized to the patient. Composition is 4:1 (fat: protein + carbohydrates). Food is weighed in grams and every part of meal must be eaten.

- The diet is high in butter, heavy cream, olive oil, coconut oil, medium chain triglycerides, and mayonnaise.

- Human case studies with glioblastoma. Several studies are currently on-going looking at potential benefits with GBM, and other cancers.

- It’s important to discuss and work with your health care team if interested in the ketogenic diet.
Summary

- Every cell in our body uses glucose for fuel
- Excess body weight carries with it increased risk for cancer as does insulin resistance
- Chose a wide variety of plant foods (vegetables, fruit, nuts/seeds/legumes, spices, whole grains) with no or minimal processing.
Eat food. Not too much. Mostly plants.

Michael Pollen, In Defense of Food: An Eater’s Manifesto