Chapter 3
Carbohydrates
Introduction

• Carbohydrates
  – Preferred energy source for many of the body’s functions
  – When available, used exclusively by brain as an energy source
  – Should not be avoided when trying to lose weight
    • Portion size and balance of nutrients is important
Dietary carbohydrates

– Polysaccharides: chains of monosaccharides
  • **Starch**: hundreds of glucose molecules in either occasionally branched chains or unbranched chains
  • **Glycogen** highly branched polysaccharide?
  • **Dietary** fibers: found in plant-derived foods; non-digestible by human digestive enzymes
A glycogen molecule contains hundreds of glucose units in highly branched chains.

A starch molecule contains hundreds of glucose molecules in either occasionally branched chains or unbranched chains.
Human enzymes can digest starch, but they cannot digest cellulose (fiber)

1α→4 linkage
Can be digested by humans

1β→4 linkage
Cannot be digested – Except termites
The Chemist’s View of Carbohydrate

• Other notes regarding fibers
  – Digestion resistant starches: classified as fibers
  – Some fibers: digested by bacteria in the human digestive tract
  – Fiber groups: soluble and insoluble fibers
Digestion and Absorption of Carbohydrates

• Goal of digestion and absorption of sugars and starches
  – Break them into small molecules that body can absorb and use
A sign that you consume too much sugar...

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Health Effects of Added Sugars?

• Added sugars
  – Consumption in recent decades
    • Dramatic upward trend
  – Leading source
    • Soft drinks
  – Excessive amounts
    • Linked to obesity, heart disease, nutrient deficiencies, and dental caries
U.S. per capita food consumption
Sugar and sweeteners (individual)

Dry weight, pounds per capita per year

- Total selected commodities
- Cane and beet sugar
- Edible syrups
- Honey
- HFCS
- Glucose
- Dextrose

HFCS stands for high fructose corn syrup. Calculated from unrounded data.


Source: U.S. Department of Agriculture and U.S. Department of Health and Human Services, Dietary Guidelines for Americans 2010, available at www.dietaryguidelines.gov. Figure 3-6, p. 29.
Regulation of Blood Glucose

• Blood glucose homeostasis
  – Insulin’s role in regulating blood glucose
    • Facilitates blood glucose uptake by the muscles and adipose tissue
    • Stimulates glycogen synthesis in the liver
  – Glucagon
    • Triggers the breakdown of liver glycogen to single glucose molecules
    • Remember “Starve-feed cycle”
Dietary Requirements:

Absolute Requirement Not Established
However Requires About 50 gm
Or 200Kcal /day

1. Maintain Kreb’s Cycle Intermediates
2. Spare Protein (Gluconeogenesis)
3. Prevent Ketosis

Recommended: 55% Total Calories

Fig. 13. Glucagon response to a carbohydrate meal in 11 normal adults.
EAT NO CHO?
Metabolic Effect Of CHO Free Diet

1. Ketosis
2. Breakdown Of Protein
3. Loss of Na+
4. Dehydration
5. These symptoms appear on the second day of CHO Free Diet.
6. Reversed by 100g of CHO/DAY.
7. Basis for weight loss on low CHO Diet.
Hypoglycemia

- Blood Sugar < 40 mg/dl
  - EFFECTS
  1. Epinephrine
  2. Tachycardia
  3. Sweating, Anxiety
  4. Hunger
  5. Weakness
  6. Confusion, Coma

PROBLEM?:
Not Specific for Hypoglycemia
HYPOGLYCEMIA NOT A COMMON PROBLEM!
## TABLE 3-3 Sample Nutrients in Sugars and Other Foods

The indicated portion of any of these foods provides approximately 100 kcalories. Notice that—for a similar number of kcalories and grams of carbohydrate—milk, legumes, fruits, grains, and vegetables offer more of the other nutrients than do the sugars.

<table>
<thead>
<tr>
<th>Foods</th>
<th>Size of 100 kcal Portion</th>
<th>Carbohydrate (g)</th>
<th>Protein (g)</th>
<th>Calcium (mg)</th>
<th>Iron (mg)</th>
<th>Vitamin A (µg)</th>
<th>Vitamin C (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk, 1% low-fat</td>
<td>1 c</td>
<td>12</td>
<td>8</td>
<td>300</td>
<td>0.1</td>
<td>144</td>
<td>2</td>
</tr>
<tr>
<td>Kidney beans</td>
<td>½ c</td>
<td>20</td>
<td>7</td>
<td>30</td>
<td>1.6</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Apricots</td>
<td>6</td>
<td>24</td>
<td>2</td>
<td>30</td>
<td>1.1</td>
<td>554</td>
<td>22</td>
</tr>
<tr>
<td>Bread, whole wheat</td>
<td>1½ slices</td>
<td>20</td>
<td>4</td>
<td>30</td>
<td>1.9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Broccoli, cooked</td>
<td>2 c</td>
<td>20</td>
<td>12</td>
<td>188</td>
<td>2.2</td>
<td>696</td>
<td>148</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sugars</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar, white</td>
<td>2 tbs</td>
<td>24</td>
<td>0</td>
<td>trace</td>
<td>trace</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Molasses, blackstrap</td>
<td>2½ tbs</td>
<td>28</td>
<td>0</td>
<td>343</td>
<td>12.6</td>
<td>0</td>
<td>0.1</td>
</tr>
<tr>
<td>Cola beverage</td>
<td>1 c</td>
<td>26</td>
<td>0</td>
<td>6</td>
<td>trace</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Honey</td>
<td>1½ tbs</td>
<td>26</td>
<td>trace</td>
<td>2</td>
<td>0.2</td>
<td>0</td>
<td>trace</td>
</tr>
</tbody>
</table>
Sugars Intake

• Recommended sugar intakes
  – Dietary Guidelines for Americans
    • Reduce the intake of kcals from added sugars
  – The USDA Food Patterns
    • Eight teaspoons for 2200 kcal (5 – 10 percent of day’s total energy intake)
  – Recognize sugar in all its forms – e.g., added sugars
Alternative Sweeteners: Nonnutritive Sweeteners

- Minimal or no carbohydrate or energy
- FDA endorsement
  - Safe over a lifetime within Acceptable Daily Intake (ADI) levels
- Do not cause tooth decay
- Safe?
Health Effects: Dietary Fibers

• Carbohydrates: recommended intakes
  – DRI advises 45 to 65 percent of energy requirement
  – Daily Values: 60 percent of kcalories
  – Fiber (a type of Carb)
    • FDA proposes 25 grams per day
    • Adequate Intake (AI): 14 g/1000 kcal/day
Health Effects of Starch and Dietary Fibers

- Fiber-rich carbohydrate foods
  - Lower risk of heart disease
  - Reduce the risk of type 2 diabetes
  - May enhance the health of the large intestine
  - Lower risk for colon cancer
  - Weight control
Carbohydrates: food sources

- Grains
- Vegetables
- Fruits
- Milk and milk products
- Protein foods: limited to nuts and dry beans
BREADS, CEREALS, LEGUMES

FIBER

- White Bread: 0.77g
- Whole Wheat Bread: 2.4g
- Rice Krispies: 1.3g
- Granola: 1.9g
- Cornflakes: 3.1g
- Shredded Wheat: 7.6g
- All-Bran: 9.3g
- Peanuts: 2.6g
- Baked Beans: 1 oz
Health Effects of Starch and Dietary Fibers

• FDA authorized health claims
  1. Fiber-containing grain products, fruits, and vegetables: reduced risk of cancer
  3. Fruits, vegetables, and grain products that contain fiber: reduced risk of coronary heart disease
  4. Soluble fiber from whole oats and from psyllium seed husk: reduced risk of coronary heart disease
  5. Whole grains: reduced risk of heart disease and certain cancers
END OF Carbohydrates
PART 1