Chapter 4

The Carbohydrates - Sugar, Starch, Glycogen, and Fiber

PowerPoint Lectures for

Nutrition: Concepts and Controversies, eleventh edition
Frances Sizer and Ellie Whitney

Lectures by Judy Kaufman, Ph.D.
• What do you think of when you hear the word “carbohydrates”?
Carbohydrates

- Name means “carbon and water (hydrate)"
- Chemical short hand CHO
Carbohydrates

- ideal nutrients to meet your body’s needs
- feeds your brain and nervous system
- keeps digestive system fit
- helps to keep your body LEAN (w/in calorie limits)
What are the 2 types of carbs?
2 Types of Carbs

1. **simple carbs** - sugars, “bad carbs” :(

2. **complex carbs** (polysaccharides) – starch or fiber, “good carbs”
WHERE DO CARBOHYDRATES COME FROM?
Where do carbohydrates come from?

**Photosynthesis:** process by which green plants make carbs.

**You need:**

1. **chlorophyll** (green pigment)
2. **sunlight**

**Process**

1. H2O (water) absorbed by roots gives hydrogen & oxygen
2. CO2 (carbon dioxide gas) absorbed by leaves gives carbon & oxygen

**Result**

Sun + water + carbon dioxide = glucose (single sugar)
• What happens to the glucose (sugar) that the plant made?
1. Used for energy by the plant itself
   • Glucose provides energy for the work done by the cells of the stem, roots, flowers, fruits.

2. Stored in a fruit or vegetable or seed for use by animals or people.
6 sugar molecules are important in nutrition

- **Monosaccharides** – single sugars (3 in each)
- **Disaccharides** – double sugars (3 in each)

A note on the glucose symbol:
The glucose molecule is really a ring of 5 carbons and 1 oxygen plus a carbon “flag.”

For convenience, glucose is symbolized as

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*a* Galactose does not occur in foods singly but only as part of lactose.

*b* The chemical bond that joins the monosaccharides of lactose differs from those of other sugars and makes lactose hard for some people to digest—lactose intolerance (see later section).
Fructose—fruit sugar (monosaccharide)

- Really sweet sugar of fruit
- Rearranged atoms in glucose molecule
- Fruits, honey, part of table sugar
- Soft drinks, ready to eat cereals
- Products that have high fructose corn syrup

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\(^b\) The chemical bond that joins the monosaccharides of lactose differs from those of other sugars and makes lactose hard for some people to digest—lactose intolerance (see later section).
High Fructose Corn Syrup

• Is it good or bad?
• Widely used commercial product
• Enzymes added to cornstarch
• Sweeter than sugar
• Diabetes & obesity directly linked to eating HFCS (Freedman & Barnouin)

taken from American Journal of Clinical Nutrition
Galactose (monosaccharide)

- Same # and kind of atoms as glucose and fructose but different arrangement
- Makes up the sugar in milk
- Rarely occurs free in nature

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Three types of monosaccharides ...

Fructose

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Fructose—glucose

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Sucrose

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Galactose (monosaccharide)

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Glucose

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Maltose

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(glucose—glucose)

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Lactose

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(glucose—galactose)

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\(a\) Galactose does not occur in foods singly but only as part of lactose.

\(b\) The chemical bond that joins the monosaccharides of lactose differs from those of other sugars and makes lactose hard for some people to digest—lactose intolerance (see later section).
Lactose | Maltose
---|---
**Disaccharides**

- glucose + galactose
- Sugar found in milk

- glucose + glucose
- Starch is being broken down like in germinating seeds or starch digestion in the human body.

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A note on the glucose symbol:
The glucose molecule is really a ring of 5 carbons and 1 oxygen plus a carbon “flag.”

For convenience, glucose is symbolized as

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³Galactose does not occur in foods singly but only as part of lactose.
²The chemical bond that joins the monosaccharides of lactose differs from those of other sugars and makes lactose hard for some people to digest—lactose intolerance (see later section).
Sucrose- beet, cane, table sugar
(disaccharide)

- fructose + glucose
- Comes from refining beets or sugar cane
- It also occurs naturally in fruits and vegetables
- Monosaccharides are absorbed into blood directly
- Disaccharides must be broken down then digested.
• Glucose is used by all of the body's cells

• Liver releases lots of glucose into the bloodstream for use.

• Liver can also convert galactose into glucose for use.

• Fructose is used by the liver for fuel OR broken down for building blocks for fat or other needed molecules.
Polysaccharides aka complex carbs (good carbs)

- Poly = many

**Starch**  Glucose units are linked in long, occasionally branched chains to make starch. Human digestive enzymes can digest these bonds, retrieving glucose. Real glucose units are so tiny that you can’t see them, even with the highest-power light microscope.

**Glycogen**  Glycogen resembles starch in that the bonds between its glucose units can be broken by human enzymes, but the chains of glycogen are more highly branched.

**Cellulose (fiber)**  The bonds that link glucose units together in cellulose are different from the bonds in starch or glycogen. Human enzymes cannot digest them.
Starch  (Polysaccharides= complex carbs = good carbs)

- Starch is a plant’s storage form of glucose
- Found in seeds
- Nutritive for humans b/c they can digest the starch into glucose.

The sugars in these fruits are diluted with water and packaged with vitamins, minerals etc.
• Storage form of glucose in animals and human beings.

• Undetectable in meats because glycogen breaks down rapidly when the animal is slaughtered.
• Structural form of glucose in plant leaves, stems, and seeds.

• Other fibers retain water and protect the seeds from drying out.

• Human digestive enzymes cannot break the chemical bonds holding the sugar units together, i.e. indigestible in human beings.
• What are the 2 types of fibers?
Soluble fibers

- Dissolve in water
- Bacteria in human colon ferment sf
- Are **viscous**: sticky, gummy, gel-like consistency. Flows slowly
- Lowers blood cholesterol, help control blood sugar
- Protects us from heart disease & diabetes
- Found in: barley, legumes, citrus fruits, oats, vegetables
**Insoluble fibers**

- Don't dissolve in water
- Retain their structure and texture after cooking
- Ease bowel movements
- Found in: outer layers of whole grain, corn, celery strings
The Need for Carbohydrates

- Glucose is a critical energy source for the nervous system: brain & red blood cells.
- Fat is not normally used by the nervous system and brain.
- Protein-rich foods are usually expensive and offer no advantage over carbohydrates.
- Sugars that hang on protein molecules are responsible for: slipperiness of mucus, affects cell to cell communication, nerve and brain cell function...
If I Want to Lose Weight and Stay Healthy, Should I Avoid Carbohydrate?

• Are carbohydrates “fattening”?  
  – NO!! They have 4 calories per gram.  
  – People who wish to lose fat, maintain lean tissue, and stay healthy should
    • Pay attention to portion size
    • Control total calories
    • Design a diet around whole foods that supply carbohydrates in balance with other nutrients
If I Want to Lose Weight and Stay Healthy, Should I Avoid Carbohydrate?

- 130 grams of carbs for adults and children
- 38 grams of total fiber for men up to 50 yrs
- 25 grams of total fiber for women up to age 50 years
Why Do Nutrition Experts Recommend Fiber-Rich Foods?

Carbohydrate rich foods provide:

- Vitamins, minerals, phytochemicals, fiber and little fat
- Promotes normal blood cholesterol
- Controls blood pressure
- Adjusts blood glucose concentration
- Maintains healthy bowel function
- Promotes healthy body weight!
Blood Glucose Control

• High-fiber foods – especially whole grains – play a key role in reducing the risk of type 2 diabetes

• How can they do this?
  – Soluble fibers trap nutrients and delay glucose absorption
<table>
<thead>
<tr>
<th>People who eat these foods...</th>
<th>People who obtain these types of fibers...</th>
<th>People who with these actions in the body...</th>
<th>People who and these probable health benefits...</th>
</tr>
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<tbody>
<tr>
<td>Barley, oats, oat bran, rye, fruits (apples, citrus), legumes (especially young green peas and black-eyed peas), seaweeds, seeds and husks, many vegetables, fibers used as food additives</td>
<td>Gums</td>
<td>Lower blood cholesterol by binding bile</td>
<td>Lower risk of heart disease</td>
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<tr>
<td></td>
<td>Pectins</td>
<td>Slow glucose absorption</td>
<td>Lower risk of diabetes</td>
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<tr>
<td></td>
<td>Psyllium&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Slow transit of food through upper GI tract</td>
<td>Lower risk of colon and rectal cancer</td>
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<tr>
<td></td>
<td>Some hemicellulose</td>
<td>Hold moisture in stools, softening them</td>
<td>Increased satiety, and may help with weight management</td>
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<td>Yield small fat molecules after fermentation that the colon can use for energy</td>
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<tr>
<td>Nonviscous, insoluble, less fermentable</td>
<td>Cellulose</td>
<td>Increase fecal weight and speed fecal passage through colon</td>
<td>Alleviate constipation</td>
</tr>
<tr>
<td>Brown rice, fruits, legumes, seeds, vegetables (cabbage, carrots, brussels sprouts), wheat bran, whole grains, extracted fibers used as food additives</td>
<td>Lignans</td>
<td>Provide bulk and feelings of fullness</td>
<td>Lower risk of diverticulosis, hemorrhoids, and appendicitis</td>
</tr>
<tr>
<td></td>
<td>Resistant starch</td>
<td></td>
<td>Lower risk of colon and rectal cancer</td>
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<td>Hemicellulose</td>
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<sup>a</sup>Psyllium, a soluble fiber derived from seeds, is used as a laxative and food additive.
How does fiber play a role in maintaining proper colon function?

- Cellulose enlarges and softens the stools
- Speeds up transit time
- Prevents **constipation**
- Lower risk of **hemorrhoids** (swelling of rectal veins)
- Lower risk of **appendicitis** (infected appendices)
- Lower risk of **diverticula** (infected pockets in colon)
Some studies support a role for fiber in defending against cancers of the colon and rectum

- Fiber attracts water, so may dilute potential cancer-causing agents from the colon.
- Bacteria ferment soluble fiber in the colon=short chain fatty acids that
  1. nourish colon cells
  2. lower ph of colon contents
- Fatty acids may
  1. activate enzymes that destroy cancer
  2. prevent the colon from inflammation
Healthy Weight Management

• How can fiber help maintain a healthy weight?
  – Whole foods rich in complex carbohydrates tend to be low in fats & added sugars= delivering less calories per bite.
  – Fiber provides a feeling of fullness.
  – Fiber delays hunger because fibers swell as they absorb water from digestive juices.
Recommendations and Intakes

Dietary Guidelines for Americans

consume between **45% to 65%** of calories from carbohydrates daily

- Most adults need between
  - Men, age 19-50    38g/day
  - Men, age 51& up   30g/day
  - Women, age 19-50  25g/day
  - Women, age 51&up  21g/day
Can My Diet Have Too Much Fiber?

- Too much fiber and too little liquids can overwhelm the digestive system.
- Too much purified fiber may displace nutrients from the diet or cause them to be lost by binding the nutrients and speeding up transit.
- Get your fiber from whole foods
### Fiber Grams Per Serving

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<thead>
<tr>
<th>Foods</th>
<th>Fiber Grams Per Serving</th>
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<tr>
<td><strong>Grains, ½ c</strong></td>
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<tr>
<td>Barley, whole-grain</td>
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<td>Oatmeal, instant</td>
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<td>Oat bran, dry</td>
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<tr>
<td><strong>Seeds, 1 tbs</strong></td>
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<td>Psyllium seeds*</td>
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<td><strong>Fruit, 1 med</strong></td>
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<td>Apple</td>
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<td>Banana</td>
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<td>Blackberries, ½ c</td>
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<td>Nectarine</td>
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<td>Orange, grapefruit</td>
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<td>Peach</td>
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<td>Pear</td>
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<td>Plum, large</td>
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<td>Prunes, ¼ c</td>
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<td><strong>Legumes, ½ c</strong></td>
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<td>Black beans</td>
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<td>Black-eyed peas</td>
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<td>Chickpeas (garbanzo beans)</td>
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<td>Kidney beans</td>
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<td>Lentils</td>
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<td>Lima beans</td>
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<td>Navy beans</td>
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<td>Northern beans</td>
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<td>Pinto beans</td>
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<tr>
<td><strong>Vegetables, ½ c</strong></td>
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<tr>
<td>Broccoli (and many other cooked vegetables)</td>
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<tr>
<td>Brussels sprouts, chopped</td>
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<td>Carrots</td>
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*Values are for cooked or ready-to-serve foods unless specified.

*Psyllium is used as a fiber laxative and fiber-rich food additive.

Whole Grains

germ: rich in oils, vitamins, minerals.

endosperm: contains starch and proteins that nourish the seed as it sprouts.

bran: rich in nutrients and fiber

husk: humans do not eat it but animals can.

People milled wheat by grinding it between two stones and blowing off the husk and using the nutrient filled germ, bran & endosperm.

Now we use machines to remove germ and bran which removes the nutrients but is whiter and has more starch.

White flour also lasts longer on shelf. Oil in the germ gets rancid over time.

Over time consumers have learned to prefer products made with white flour.
Table 4-4

Terms That Describe Grain Foods

- **bran** the protective fibrous coating around a grain; the chief fiber donator of a grain.
- **brown bread** bread containing ingredients such as molasses that lend a brown color; may be made with any kind of flour, including white flour.
- **endosperm** the bulk of the edible part of a grain, the starchy part.
- **enriched, fortified** refers to the addition of nutrients to a refined food product. As defined by U.S. law, these terms mean that specified levels of thiamin, riboflavin, niacin, folate, and iron have been added to refined grains and grain products. The terms *enriched and fortified* can refer to the addition of more nutrients than just these five; read the label.
- **germ** the nutrient-rich inner part of a grain.
- **husk** the outer, inedible part of a grain.
- **multi-grain** a term used on food labels to indicate a food made with more than one kind of grain. Not an indicator of a whole-grain food.
- **refined** refers to the process by which the coarse parts of food products are removed. For example, the refining of wheat into white enriched flour involves removing three of the four parts of the kernel—the chaff, the bran, and the germ—leaving only the endosperm, composed mainly of starch and a little protein.
- **refined grains** grains and grain products from which the bran, germ, or other edible parts of whole grains have been removed; not a whole grain. Many refined grains are low in fiber and are enriched with vitamins as required by U.S. regulations.
- **stone ground** refers to a milling process using limestone to grind any grain, including refined grains, into flour.
- **unbleached flour** a beige-colored refined endosperm flour with texture and nutritive qualities that approximate those of regular white flour.
- **wheat bread** bread made with any wheat flour, including refined enriched white flour.
- **wheat flour** any flour made from wheat, including refined white flour.
- **white flour** an endosperm flour that has been refined and bleached for maximum softness and whiteness.
- **white wheat** a wheat variety developed to be paler in color than common red wheat (most familiar flours are made from red wheat). White wheat is similar to red wheat in carbohydrate, protein, and other nutrients, but it lacks the dark and bitter, but potentially beneficial, phytochemicals of red wheat.
- **100% whole grain** a label term for food in which the grain is entirely whole grain, with no added refined grains.
- **whole-wheat flour** flour made from whole-wheat kernels; a whole-grain flour. Also called *graham flour*.

*Formerly, enriched and fortified carried distinct meanings with regard to the nutrient amounts added to foods, but a change in the law has made these terms virtually synonymous.*
Consumer Corner: Refined, Enriched, and Whole-Grain Bread

• The U.S. Enrichment Act of 1942 was passed by Congress to prevent deficiencies that developed when people turned to refined breads.
  – Required iron, niacin, thiamin and riboflavin be added to all refined grain products
  – Amended in 1996 to include the vitamin folate (folic acid on food labels)
Figure 4-9

Key:
- Whole-grain bread
- Enriched white bread
- Unenriched white bread

Nutrients in bread:
- Iron: whole-grain bread 83%, enriched white bread 21%, unenriched white bread
- Thiamin: whole-grain bread >100%, enriched white bread 26%, unenriched white bread
- Riboflavin: whole-grain bread >100%, enriched white bread 28%, unenriched white bread
- Niacin: whole-grain bread 98%, enriched white bread 9%, unenriched white bread
- Vitamin B6: whole-grain bread 100%, enriched white bread 18%, unenriched white bread
- Folate: whole-grain bread 100%, enriched white bread 64%, unenriched white bread
- Fiber: whole-grain bread 100%, enriched white bread 24%, unenriched white bread
- Magnesium: whole-grain bread 100%, enriched white bread 23%, unenriched white bread
- Zinc: whole-grain bread 36%, enriched white bread 36%, unenriched white bread

Percentage of nutrients
(100% represents nutrient levels of whole-grain bread)
Body must have glucose available for its cells at a steady rate all day. 

Body cannot use polysaccharides or disaccharides or even fructose or galactose.

Glucose is needed
Figure 4-11 p131

1. Some starch is partially broken down by an enzyme from the salivary glands of the mouth.

2. Fiber, starch, monosaccharides, and disaccharides enter the stomach and pass into the small intestine.

3. An enzyme from the pancreas digests most of the starch to disaccharides.

4. Enzymes on the surface of cells that line the intestine split disaccharides to monosaccharides.

5. Monosaccharides enter capillaries and are then delivered to the liver via the portal vein.

6. The liver can convert galactose and fructose to glucose.

7. Fiber and resistant starch travel unchanged to the colon.

Key:
- glucose
- galactose
- lactose
- sucrose
- starch
- fiber

Intestinal wall cells
Capillary
Starch digestion begins in the mouth.

Enzyme (made of protein) in saliva mixes with food

Starch is split into maltose

Once in the stomach, starch digestion stops b/c stomach acid digests protein. Salivary enzymes (made of protein) is deactivated by stomach's protein digesting enzyme.

Continues in the small intestine breaks down starch into di and small polysaccharides.

Other enzymes free the monosaccharides for absorption
• Disaccharides are split to monosaccharides
• Monosaccharides are absorbed
• Galactose, fructose, and glucose travel to liver which converts galactose and fructose to glucose or related products
Sugars

- Circulatory system transports glucose and other products to cells
- Liver may store some glucose as glycogen
- All body cells may split glucose for energy
Fiber

- Fiber is not digested by human digestive enzymes
- Fiber is fermented by colon bacteria producing odorous gases
- Don't give up on fiber foods that cause gas
- Start with small servings and increase later
Why Do Some People Have Trouble Digesting Milk?

- As people age, upward of 75% of the world’s people lose the ability to produce the enzyme lactase which digests lactose.
- Almost all mammals lose some of their ability to produce lactase as they age.
- 12% of US population develops lactose intolerance
- 80% of African, Asian, Hispanic, Native American, and Indian may develop lactose intolerance.
Symptoms of Lactose Intolerance

- Symptoms of lactose intolerance after consuming lactose-containing products:
  - Nausea
  - Pain
  - Diarrhea
  - Excessive gas

- Milk allergy is due to the immune system’s reaction to milk protein.
Milk Tolerance and Strategies

• Many people can tolerate as much as 1-2 cups of milk a day

• Alternatives include (according to the text book)
  – Cheese
  – Yogurt
  – Lactose-free milk
  – Over-the-counter lactase pills and drops
  – Calcium-fortified juices, soymilk, canned sardines or salmon with the bones

The best lifestyle choice is to get dairy out of your life for good and forever!!!!!!!
The Body’s Use of Glucose

- Glucose is the basic carbohydrate that each cell of the body uses for energy
Cell splits glucose in \( \frac{1}{2} \) to use some of the energy

1. glucose can be put back together to make glucose again

2. broken further in to smaller molecules (from this point they can't be put back together)
   - releasing more energy = breaking down to carbon dioxide & water
   - carbs CAN be made into building blocks of protein
   - hitched together into units of body fat
Below a Healthy Minimum - Ketosis

• When there is inadequate carbohydrate in the diet, the body has two problems:
  
  1. Having no glucose, the body turns to protein and fat to make some glucose.

    • Called the protein-sparing action of carbohydrate

    • Protein is needed for maintaining immune system and other critical functions.

    • Body will use blood, organ & muscle protein to make carbs

    • Fat cannot regenerate enough glucose to feed the brain and prevent ketosis
2. Without carbohydrate in the diet, fat cannot be used correctly for energy, and the body converts its fats into ketone bodies.

- fat + glucose compounds = energy supplies

Instead

- fat + fat = ketone bodies = ketosis

- Disturbs acid base balance in body

- vitamin & mineral deficiencies, loss of bone minerals, bad moods, + of kidney stones ...
Storing Glucose as Glycogen

• After a meal, as blood glucose rises, the pancreas releases **insulin**, which signals the body’s tissues to take up the surplus glucose.
  – Muscle and liver cells can convert the excess glucose to glycogen
  – Muscle store 2/3 of total glycogen for its own use
  – Brain stores a little glycogen
  – Liver stores the rest for the brain or other tissue when body is low in glucose
Storing Glucose as Glycogen

- When blood glucose concentrations drop, a pancreatic hormone, **glucagon**, is released.
- Glucagon liberates stored glucose from liver glycogen.
Maintaining Glucose in the Blood

- Healthy body keeps blood glucose concentrations from becoming too low or too high.
- Too much glucose = confusion, difficulty breathing
- Too little = dizziness and weakness
Regulation of Blood Glucose

- Regulating blood sugar depends on two pancreatic hormones:
  - **Insulin** – removes excess glucose from blood to become glycogen or fat *(when too much)*
  - **Glucagon** – triggers the breakdown of liver glycogen to free glucose. *(when too little)*

* Epinephrine also breaks down liver glycogen during emergencies (“fight or flight” reaction)
**High blood glucose**

1. After a meal, blood glucose rises, signaling the pancreas to release insulin into the bloodstream.

2. Insulin signals fat (adipose) tissue and skeletal muscles to take up glucose from the blood. It also stimulates glycogen storage by the liver.

3. Blood glucose falls to its normal concentration.

4. In response to normal blood glucose, the pancreas slows its insulin output.

**Low blood glucose**

5. As body cells use up glucose, blood glucose declines, signaling the pancreas to release glucagon into the bloodstream.

6. Glucagon signals the liver to break apart its stored glycogen, releasing glucose into the bloodstream.

7. Blood glucose rises to its normal concentration.

8. In response to normal blood glucose, the pancreas slows its glucagon output.
Handling Excess Glucose

• Excess dietary glucose is converted in the liver to:
  - Glycogen – (liver and muscles hold a limited amount, 4 to 6 hours worth) if you are consuming more glucose
  - Body energy shifts to burning more glucose than fat
  - So more fat is left circulating in the blood which is picked up by fatty tissue and stored there still more glucose coming
  - Liver breaks glucose into smaller fragments and makes fats which is released into the blood stream and taken to fat tissues and deposited there
Handling Excess Glucose

- Fat cells can also directly take glucose and convert them into fat.
- Fat cells can store unlimited amounts of fat.
- When you eat foods that have too much glucose and fat your body will use the glucose first (b/c it takes less energy) and store the fat.

Be careful of how much sugar and fat you consume throughout the day.
The Perils of Diabetes

- Almost 26 million people in US have diabetes.
- 7 million are unaware.
- 79 million are prediabetic.
- Leading cause of death in US.
- Doubles the risk of heart disease and stroke.
- Leading cause of permanent blindness and fatal kidney failure and amputations.
Harm to the Body

- Chronically elevated blood glucose alters metabolism in every cell in the body
  - Blindness
  - Kidney disease
  - Heart disease
  - Nerve damage
  - Increased infections
  - Amputations of limbs
Type 1 Diabetes

- Type 1 causes 5 to 10 percent of diabetes
- **Autoimmune disorder** where person’s immune system attacks insulin-producing pancreatic cells
- External sources of insulin needed to assist cells to take up glucose
Type 2 Diabetes

• Type 2 causes 90 to 95 percent of diabetes in adults & children

• Muscle, adipose, and liver cells lose their sensitivity to insulin, i.e. **insulin resistance**

• Resulting in high levels of glucose in the body
- Obesity-related in young and older people
- Genetic factors also involved
Preventing Type 2 Diabetes

- Maintain healthy body weight
- Choose a diet high in vegetables, fruits, poultry, fish, and whole grains
- Exercise regularly
- Restrict alcohol
- Abstain from smoking
### Table 4-8

**Type 1 and Type 2 Diabetes Compared**

<table>
<thead>
<tr>
<th></th>
<th>Type 1</th>
<th>Type 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of cases</td>
<td>5–10%</td>
<td>90–95%</td>
</tr>
<tr>
<td>Age of onset</td>
<td>&lt;30 years</td>
<td>&gt;40 years&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Associated characteristics</td>
<td>Autoimmune diseases, viral infections, inherited factors</td>
<td>Obesity, aging, inherited factors</td>
</tr>
<tr>
<td>Primary problems</td>
<td>Destruction of pancreatic beta cells; insulin deficiency</td>
<td>Insulin resistance, insulin deficiency (relative to needs)</td>
</tr>
<tr>
<td>Insulin secretion</td>
<td>Little or none</td>
<td>Varies; may be normal, increased, or decreased</td>
</tr>
<tr>
<td>Requires insulin</td>
<td>Always</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Older names</td>
<td>Juvenile-onset diabetes</td>
<td>Adult-onset diabetes</td>
</tr>
<tr>
<td></td>
<td>Insulin-dependent diabetes mellitus (IDDM)</td>
<td>Noninsulin-dependent diabetes mellitus (NIDDM)</td>
</tr>
</tbody>
</table>

<sup>a</sup>Incidence of type 2 diabetes is increasing in children and adolescence; in more than 90% of these cases, it is associated with overweight or obesity and a family history of type 2 diabetes.
Management of Diabetes

- The tighter the control over blood glucose, the milder the effects of diabetes can be

- Lifestyle changes

- Eat a healthy diet that delivers the same amount of carbohydrate each day, spaced evenly throughout the day

- Not too much protein

- Adequate in fiber

- Low in fat
If I Feel Dizzy Between Meals, Do I Have Hypoglycemia?

- Hypoglycemia is abnormally low blood glucose
- Requires a blood test to diagnose
- Two types
  - Postprandial – low blood glucose after a meal; uncommon. Fatigue, weakness, dizziness, sweating...
  - Fasting – 8-14 hours. Headaches, mental dullness, fatigue, confusion, amnesia...
Food Feature: Finding the Carbohydrates in Foods

- For a 2,000-calorie diet
  - Carbohydrates should provide 45% to 65% of calories
  - 225 to 325 grams each day
### Fruits

<table>
<thead>
<tr>
<th>Food</th>
<th>Fiber (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pear, raw, 1 medium</td>
<td>5</td>
</tr>
<tr>
<td>Blackberries/raspberries, raw, 1/2 c</td>
<td>4</td>
</tr>
<tr>
<td>Prunes, cooked, 1/4 c</td>
<td>4</td>
</tr>
<tr>
<td>Figs, dried, 3</td>
<td>3</td>
</tr>
<tr>
<td>Apple, 1 medium</td>
<td>3</td>
</tr>
<tr>
<td>Apricots, raw, 4 each</td>
<td>3</td>
</tr>
<tr>
<td>Banana, raw, 1</td>
<td>3</td>
</tr>
<tr>
<td>Orange, 1 medium</td>
<td>3</td>
</tr>
<tr>
<td>Other berries, raw, 1/2 c</td>
<td>2</td>
</tr>
<tr>
<td>Peach, raw, 1 medium</td>
<td>2</td>
</tr>
<tr>
<td>Strawberries, sliced, 1/2 c</td>
<td>2</td>
</tr>
<tr>
<td>Cantaloupe, raw, 1/2 c</td>
<td>1</td>
</tr>
<tr>
<td>Cherries, raw, 1/2 c</td>
<td>1</td>
</tr>
<tr>
<td>Fruit cocktail, canned, 1/2 c</td>
<td>1</td>
</tr>
<tr>
<td>Peach half, canned</td>
<td>1</td>
</tr>
<tr>
<td>Raisins, dry, 1/4 c</td>
<td>1</td>
</tr>
<tr>
<td>Orange juice, 3/4 c</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

### Vegetables

<table>
<thead>
<tr>
<th>Food</th>
<th>Fiber (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baked potato with skin, 1</td>
<td>4</td>
</tr>
<tr>
<td>Broccoli, chopped, 1/2 c</td>
<td>3</td>
</tr>
<tr>
<td>Brussel sprouts, 1/2 c</td>
<td>3</td>
</tr>
<tr>
<td>Spinach, 1/2 c</td>
<td>3</td>
</tr>
<tr>
<td>Asparagus, 1/2 c</td>
<td>2</td>
</tr>
<tr>
<td>Baked potato, no skin, 1</td>
<td>2</td>
</tr>
<tr>
<td>Cabbage, red, 1/2 c</td>
<td>2</td>
</tr>
<tr>
<td>Carrots, 1/2 c</td>
<td>2</td>
</tr>
<tr>
<td>Cauliflower, 1/2 c</td>
<td>2</td>
</tr>
<tr>
<td>Corn, 1/2 c</td>
<td>2</td>
</tr>
<tr>
<td>Green beans, 1/2 c</td>
<td>2</td>
</tr>
<tr>
<td>Mashed potatoes, home recipe, 1/2 c</td>
<td>2</td>
</tr>
<tr>
<td>Bell peppers, 1/2 c</td>
<td>1</td>
</tr>
<tr>
<td>Broccoli, raw, chopped, 1/2 c</td>
<td>1</td>
</tr>
<tr>
<td>Carrot juice, 1/2 c</td>
<td>1</td>
</tr>
<tr>
<td>Celery, 1/2 c</td>
<td>1</td>
</tr>
<tr>
<td>Dill pickle, 1 whole</td>
<td>1</td>
</tr>
<tr>
<td>Eggplant, 1/2 c</td>
<td>1</td>
</tr>
<tr>
<td>Lettuce, romaine, 1 c</td>
<td>1</td>
</tr>
<tr>
<td>Onions, 1/2 c</td>
<td>1</td>
</tr>
<tr>
<td>Tomato, raw, 1 medium</td>
<td>1</td>
</tr>
<tr>
<td>Tomato juice, canned, 3/4 c</td>
<td>1</td>
</tr>
</tbody>
</table>

### Grains

<table>
<thead>
<tr>
<th>Food</th>
<th>Fiber (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% bran cereal, 1 oz</td>
<td>10</td>
</tr>
<tr>
<td>Barley, pearled, 1/2 c</td>
<td>3</td>
</tr>
<tr>
<td>Cheerios, 1 oz</td>
<td>3</td>
</tr>
<tr>
<td>Whole-wheat bread, 1 slice</td>
<td>3</td>
</tr>
<tr>
<td>Whole-wheat pasta, 1/2 c</td>
<td>3</td>
</tr>
<tr>
<td>Wheat flakes, 1 oz</td>
<td>3</td>
</tr>
<tr>
<td>Brown rice, 1/2 c</td>
<td>2</td>
</tr>
<tr>
<td>Light rye bread, 1 slice</td>
<td>2</td>
</tr>
<tr>
<td>Muffin, bran, 1 small</td>
<td>2</td>
</tr>
<tr>
<td>Oatmeal, 1/2 c</td>
<td>2</td>
</tr>
<tr>
<td>Popcorn, 2 c</td>
<td>2</td>
</tr>
<tr>
<td>Pumpernickel bread, 1 slice</td>
<td>2</td>
</tr>
<tr>
<td>Shredded wheat, 1 large biscuit</td>
<td>2</td>
</tr>
<tr>
<td>Corn flakes, 1 oz</td>
<td>1</td>
</tr>
<tr>
<td>Muffin, blueberry, 1/2 c</td>
<td>1</td>
</tr>
<tr>
<td>Puffed wheat, 1/2 c</td>
<td>1</td>
</tr>
<tr>
<td>White pasta, 1/2 c</td>
<td>1</td>
</tr>
<tr>
<td>Cream of wheat, 1/2 c</td>
<td>&lt;1</td>
</tr>
<tr>
<td>White bread, 1 slice</td>
<td>&lt;1</td>
</tr>
<tr>
<td>White rice, 1/2 c</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

### Meat, Poultry, Fish, Dry Peas and Beans, Eggs, and Nuts

<table>
<thead>
<tr>
<th>Food</th>
<th>Fiber (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lentils, 1/2 c</td>
<td>8</td>
</tr>
<tr>
<td>Kidney beans, 1/2 c</td>
<td>8</td>
</tr>
<tr>
<td>Pinto beans, 1/2 c</td>
<td>8</td>
</tr>
<tr>
<td>Black beans, 1/2 c</td>
<td>7</td>
</tr>
<tr>
<td>Black-eyed peas, 1/2 c</td>
<td>6</td>
</tr>
<tr>
<td>Lima beans, 1/2 c</td>
<td>5</td>
</tr>
<tr>
<td>Soybeans, 1/2 c</td>
<td>5</td>
</tr>
<tr>
<td>Almonds or mixed nuts, 1/4 c</td>
<td>4</td>
</tr>
<tr>
<td>Peanuts, 1/4 c</td>
<td>3</td>
</tr>
<tr>
<td>Peanut butter, 2 lbs</td>
<td>2</td>
</tr>
<tr>
<td>Cashew nuts, 1/4 c</td>
<td>1</td>
</tr>
<tr>
<td>Meat, poultry, fish, and eggs</td>
<td>0</td>
</tr>
</tbody>
</table>

*All values are for ready-to-eat or cooked foods unless otherwise noted. Fruit values include edible skins. All values are rounded values.

*Pasta includes spaghetti noodles, lasagna, and other noodles.*
Terms That Describe Sugar

Note: The term sugars here refers to all of the monosaccharides and disaccharides. On a label’s ingredients list, the term sugar means sucrose. See Controversy 4 for terms related to artificial sweeteners and sugar alcohols.

- **Added sugars** sugars and syrups added to a food for any purpose, such as to add sweetness or bulk or to aid in browning (baked goods). Also called carbohydrate sweeteners, they include glucose, fructose, corn syrup, concentrated fruit juice, and other sweet carbohydrates.
- **Brown sugar** white sugar with molasses added, 95% pure sucrose.
- **Concentrated fruit juice sweetener** a concentrated sugar syrup made from dehydrated, deflavored fruit juice, commonly grape juice; used to sweeten products that can then claim to be “all fruit.”
- **Confectioner’s sugar** finely powdered sucrose, 99.9% pure.
- **Corn sweeteners** corn syrup and sugar solutions derived from corn.
- **Corn syrup** a syrup, mostly glucose, partly maltose, produced by the action of enzymes on cornstarch.
- **Dextrose** an older name for glucose.
- **Evaporated cane juice** raw sugar from which impurities have been removed.
- **Fructose, galactose, glucose** the monosaccharides.
- **Granulated sugar** common table sugar, crystalline sucrose, 99.9% pure.
- **High fructose corn syrup** a commercial sweetener used in many foods, including soft drinks. Composed almost entirely of the monosaccharides fructose and glucose, its sweetness and caloric value are similar to sucrose.
- **Honey** a concentrated solution primarily composed of glucose and fructose, produced by enzymatic digestion of the sucrose in nectar by bees.
- **Invert sugar** a mixture of glucose and fructose formed by the splitting of sucrose in an industrial process. Sold only in liquid form and sweeter than sucrose, invert sugar forms during certain cooking procedures and works to prevent crystallization of sucrose in soft candies and sweets.
- **Lactose, maltose, sucrose** the disaccharides.
- **Levulose** an older name for fructose.
- **Maple sugar** a concentrated solution of sucrose derived from the sap of the sugar maple tree, mostly sucrose. This sugar was once common but is now usually replaced by sucrose and artificial maple flavoring.
- **Molasses** a syrup left over from the refining of sucrose from sugarcane; a thick, brown syrup. The major nutrient in molasses is iron, a contaminant from the machinery used in processing it.
- **Naturally occurring sugars** sugars that are not added to a food but are present as its original constituents, such as the sugars of fruit or milk.
- **Raw sugar** the first crop of crystals harvested during sugar processing. Raw sugar cannot be sold in the United States because it contains too much filth (dirt, insect fragments, and the like). Sugar sold as “raw sugar” is actually evaporated cane juice.
- **Turbinado (ter-bih-NOD-oh) sugar** raw sugar from which the filth has been washed; legal to sell in the United States.
- **White sugar** pure sucrose, produced by dissolving, concentrating, and recrystallizing raw sugar.
### Strawberry Jam Nutrition Facts

**Serving size:** 1 Tbsp (20g)

**Servings Per Container:** About 14

<table>
<thead>
<tr>
<th>Amount per serving</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories</td>
<td>40</td>
</tr>
<tr>
<td>Calories from Fat</td>
<td>0</td>
</tr>
<tr>
<td>% Daily Value</td>
<td>*</td>
</tr>
<tr>
<td>Total Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Sodium</td>
<td>1mg</td>
</tr>
<tr>
<td>Total Carbohydrate</td>
<td>10g</td>
</tr>
<tr>
<td>Sugars</td>
<td>7g</td>
</tr>
<tr>
<td>Protein</td>
<td>0g</td>
</tr>
</tbody>
</table>

*Percent Daily Values are based on a 2,000 calorie diet.

**INGREDIENTS:** Strawberries, Corn Syrup, Sugar, High Fructose Corn Syrup, Citric Acid, Fruit Pectin.

### Strawberry 100% Fruit Spread Nutrition Facts

**Serving size:** 1 Tbsp (18g)

**Servings Per Container:** About 16

<table>
<thead>
<tr>
<th>Amount per serving</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories</td>
<td>40</td>
</tr>
<tr>
<td>Calories from Fat</td>
<td>0</td>
</tr>
<tr>
<td>% Daily Value</td>
<td>*</td>
</tr>
<tr>
<td>Total Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Sodium</td>
<td>0mg</td>
</tr>
<tr>
<td>Total Carbohydrate</td>
<td>10g</td>
</tr>
<tr>
<td>Sugars</td>
<td>8g</td>
</tr>
<tr>
<td>Protein</td>
<td>0g</td>
</tr>
</tbody>
</table>

*Percent Daily Values are based on a 2,000 calorie diet.

**INGREDIENTS:** Clarified Grape Juice Concentrate, Strawberries, Clarified Pear Juice Concentrate, Pectin, Natural Flavor, Citric Acid.
Food Feature: Finding the Carbohydrates in Foods
• Honey is more nutritious than sugar.
  
  1. Agree
  2. Disagree
Food Feature: Finding the Carbohydrates in Foods

### The Empty Calories of Sugar

At first glance, honey, jelly, and brown sugar look more nutritious than plain sugar, but when compared with a person’s nutrient needs, none contributes anything to speak of. The cola beverage is clearly an empty-calorie item, too.

<table>
<thead>
<tr>
<th>FOOD</th>
<th>ENERGY (cal)</th>
<th>PROTEIN (g)</th>
<th>FIBER (g)</th>
<th>CALCIUM (mg)</th>
<th>IRON (mg)</th>
<th>MAGNESIUM (mg)</th>
<th>POTASSIUM (mg)</th>
<th>ZINC (mg)</th>
<th>VITAMIN A (μg)</th>
<th>THIAMIN (mg)</th>
<th>RIBOFLAVIN (mg)</th>
<th>NIACIN (mg)</th>
<th>VITAMIN B₆ (mg)</th>
<th>FOLATE (μg)</th>
<th>VITAMIN C (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar (1 tbs)</td>
<td>46</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Honey (1 tbs)</td>
<td>64</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0.1</td>
<td>0</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>&lt;1</td>
<td>0</td>
</tr>
<tr>
<td>Molasses (1 tbs)</td>
<td>55</td>
<td>0</td>
<td>0</td>
<td>42</td>
<td>1.0</td>
<td>50</td>
<td>300</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Concentrated grape or fruit juice sweetener (1 tbs)</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Jelly (1 tbs)</td>
<td>49</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Brown sugar (1 tbs)</td>
<td>34</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>0.2</td>
<td>3</td>
<td>31</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cola beverage (12 fl oz)</td>
<td>153</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td>0.1</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Daily Values</td>
<td>2,000</td>
<td>56</td>
<td>25</td>
<td>1,000</td>
<td>18</td>
<td>400</td>
<td>3,500</td>
<td>15</td>
<td>1,000</td>
<td>1.5</td>
<td>1,7</td>
<td>20</td>
<td>2</td>
<td>400</td>
<td>60</td>
</tr>
</tbody>
</table>
Controversy: Sugar and Alternative Sweeteners: Are They Bad For You?

- Sugary soft drinks are the leading source of added sugars in the US
Controversy: Sugar and Alternative Sweeteners: Are They Bad For You?

The chart shows the increase in daily teaspoons of sugars from 1890 to today.

- 1890: 5 teaspoons
- 1970: 25 teaspoons
- 1980: 30 teaspoons
- 1990: 35 teaspoons
- Today: 35 teaspoons

The suggested upper daily limit is indicated by a red line.
• Sugar has been accused of
  – Promoting and maintaining obesity
  – Causing and aggravating diabetes
  – Increasing the risk of heart disease
  – Disrupting behavior in children and adults
  – Causing dental decay and gum disease
Does Sugar Cause Obesity?

- Any weight gain associated with sugars may result not so much with the chemistry of the carbohydrate itself, but with how it is used in the diet.
- Most people choose far too many servings of sweet foods and beverages (juices/sodas), while ignoring the whole carbohydrate sources, such as fruits, vegetables, and whole grains.
Added sugars alone are not culpable in type 2 diabetes causation.

Added sugars can easily provide excess calories, however, and type 2 diabetes risk rises with body weight.
Throughout many years of research, no evidence has come to light linking an average intake of sugar with heart disease.
• Research results do not suggest that sugar itself negatively affects behavior in either normal or hyperactive children.

• In fact, in several well-controlled studies, sugar administered to normal children calmed them down, a finding consistent with biochemical evidence. In adults, carbohydrate-rich foods seem to improve memory and mood.
• Total sugar does play a major role in the prevalence of dental caries.

Caries begin when acid dissolves the enamel that covers the tooth. If not repaired, the decay may penetrate the dentin and spread into the pulp of the tooth, causing inflammation and an abscess.

**Table C4-1 Dental Terms**

- **dental caries** decay of the teeth *(caries means “rottenness”).*
- **plaque** (PLACK) a mass of microorganisms and their deposits on the crowns and roots of the teeth, a forerunner of dental caries and gum disease. *(The term plaque is also used in another connection—arterial plaque in atherosclerosis. See Chapter 11.)*
Personal Strategy For Using Sugar

• Based on research, no guilty verdict can yet be issued for any of the first four accusations against sugar, but of the fifth, it is guilty as charged - sugar causes dental caries.
Dietary Guidelines suggest limiting sugar

Sugar can safely contribute up to 10 percent of the total calorie intake

- 2000-calorie diet can have up to 200 calories of sugar (13 teaspoons)

To lower sugar intake, many choose alternative sweeteners
# Evidence Concerning Sugar Alcohols

## Table C4-2: Sugar Alcohols

<table>
<thead>
<tr>
<th>Sugar Alcohols</th>
<th>Relative Sweetness</th>
<th>Energy (cal/g)</th>
<th>Approved Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erythritol</td>
<td>1.0</td>
<td>0.0</td>
<td>Beverages, flavored milk, yogurt, and pudding, frozen dairy desserts, bakery products, chewing gum, candies, table sweetener</td>
</tr>
<tr>
<td>Isomalt</td>
<td>0.5</td>
<td>2.0</td>
<td>Candies, chewing gum, ice cream, jams and jellies, frostings, beverages, baked goods</td>
</tr>
<tr>
<td>Lactitol</td>
<td>0.4</td>
<td>2.0</td>
<td>Candies, chewing gum, frozen dairy desserts, jams and jellies, frostings, baked goods</td>
</tr>
<tr>
<td>Maltitol</td>
<td>0.9</td>
<td>2.1</td>
<td>Particularly good for candy coating</td>
</tr>
<tr>
<td>Mannitol</td>
<td>0.7</td>
<td>1.6</td>
<td>Bulking agent, chewing gum</td>
</tr>
<tr>
<td>Sorbitol</td>
<td>0.5</td>
<td>2.6</td>
<td>Special dietary foods, candies, gums</td>
</tr>
<tr>
<td>Xylitol</td>
<td>1.0</td>
<td>2.4</td>
<td>Chewing gum, candies, pharmaceutical and oral health products</td>
</tr>
</tbody>
</table>

*The relative sweetness depends on the temperature, acidity, and other flavors of the foods in which the substance occurs. The sweetness of pure sucrose is the standard with which the approximate sweetness of sugar substitutes is compared.*
Evidence Concerning Sugar Alcohols

• Do not contribute to dental caries because not metabolized by oral bacteria

• Low glycemic index so useful for diabetics

• Side effects from ingesting large amounts
  – Gas
  – Abdominal discomfort
  – Diarrhea
### Table C4-3: Sugar Substitute Terms

- **acceptable daily intake (ADI)**: the estimated amount of sweetener that can be consumed daily over a person’s lifetime without any adverse effects.
- **acesulfame (AY-sul-fame) potassium**, also called **acesulfame-K**: a zero-calorie sweetener approved by the FDA and Health Canada.
- **alitame**: a noncaloric sweetener formed from the amino acids L-aspartic acid and L-alanine. In the United States, the FDA is considering its approval.
- **aspartame**: a compound of phenylalanine and aspartic acid that tastes like the sugar sucrose but is much sweeter. It is used in both the United States and Canada.
- **cyclamate**: a zero-calorie sweetener under consideration for use in the United States and used with restrictions in Canada.
- **isomalt, lactitol, maltitol, mannitol, sorbitol, xylitol**: sugar alcohols that can be derived from fruits or commercially produced from a sugar; absorbed more slowly and metabolized differently than other sugars in the human body and not readily used by ordinary mouth bacteria.
- **neotame (NEE-oh-tame)**: an artificial sweetener composed of two amino acids (phenylalanine and aspartic acid) linked in such a way as to make them indigestible by human enzymes.
- **saccharin**: a zero-calorie sweetener used freely in the United States but restricted in Canada.
- **stevia (STEVEE-ee-uh)**: the sweet-tasting leaves of a shrub sold as a dietary supplement, but lacking FDA approval as a sweetener.
- **sucralose**: a noncaloric sweetener derived from a chlorinated form of sugar that travels through the digestive tract unabsorbed. Approved for use in the United States and Canada.
- **tagatose**: an incompletely absorbed monosaccharide sweetener derived from lactose with a caloric value of 1.5 calories per gram. About 80% of the ingested tagatose travels to the large intestine where bacterial colonies ferment it. Tagatose is not readily used by mouth bacteria and so does not promote dental caries.
# Evidence Concerning Artificial Sweeteners

## Table C4-4 U.S. Approved Artificial Sweeteners and Sugar-Based Sweeteners

<table>
<thead>
<tr>
<th>ARTIFICIAL SWEETENERS</th>
<th>ENERGY (cal/g)</th>
<th>ACCEPTABLE DAILY INTAKE (ADI)</th>
<th>AVERAGE AMOUNT TO REPLACE 1 TSP SUCROSE</th>
<th>APPROVED USES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saccharin (SugarTwin, Sweet N’ Low, others)</td>
<td>0</td>
<td>5 mg/kg body weight (341 mg for a 150 lb person)</td>
<td>12 mg</td>
<td>Tabletop sweeteners, wide range of foods, beverages, cosmetics, and pharmaceutical products</td>
</tr>
<tr>
<td>Aspartame (Nutra-Sweet, Equal, others)</td>
<td>4</td>
<td>50 mg/kg body weight(^b) (3,409 mg for a 150 lb person)</td>
<td>18 mg</td>
<td>General-purpose sweetener in all foods and beverages. Warning to population with PKU</td>
</tr>
<tr>
<td>Acesulfame-potassium (Sunette, Sweet One)</td>
<td>0</td>
<td>15 mg/kg body weight (1,023 mg for a 150 lb person)</td>
<td>25 mg</td>
<td>Alcoholic beverages, baked goods, candies, chewing gum, desserts, gelatins, puddings, tabletop sweeteners</td>
</tr>
<tr>
<td>Sucralose (Splenda)</td>
<td>0</td>
<td>5 mg/kg body weight (341 mg for a 150 lb person)</td>
<td>6 mg</td>
<td>Baked goods, carbonated beverages, chewing gum, coffee and tea, dairy products, frozen desserts, fruit spreads, salad dressing, syrups, tabletop sweeteners</td>
</tr>
<tr>
<td>Neotame</td>
<td>0</td>
<td>18 mg/day</td>
<td>0.5 (\mu)g</td>
<td>Baked goods, beverages (nonalcoholic), candies, chewing gum, frostings, frozen desserts, gelatins, puddings, jams and jellies, syrups</td>
</tr>
<tr>
<td>Tagatose</td>
<td></td>
<td>7.5 g/day</td>
<td>1 tsp</td>
<td>Bakery products, beverages, cereals, chewing gum, confections, dairy products, dietary supplements, health bars, tabletop sweeteners</td>
</tr>
</tbody>
</table>

\(^a\)Rounded values

\(^b\)In Canada, the acceptable level is 40 mg/kg.
Can Artificial Sweeteners Help With Weight Control?
Do Artificial Sweeteners Help With Weight Control?

- A recent study reports sizable weight losses when artificial sweeteners replace sizable amounts of sugar in the diet.
- Some studies report no weight loss differences between people fed sugar and those fed artificial sweeteners.
Personal Strategies For Using Artificial Sweeteners

• Current evidence indicates that moderate intakes of artificial sweeteners pose no health risks.

• Artificial sweeteners may not be a magic bullet in fighting overweight, but they probably do not hinder weight-loss efforts either, and they are safer for teeth than carbohydrate sweeteners.