Chapter 4: The Carbohydrates/Sugars, Starches and Fibers

Glucose:

- $C_6H_{12}O_6$ (chemical structure is shown in Fig. 4-2 of your text)
    - the short-cut version (middle illustration) does not show all of the carbons in the structure, but you should be able to study the textbook illustrations and see that the six carbons are represented
    - this is the structure that you will see used most often in your textbook as well as in other textbooks/materials

Three Monosaccharides: all have $C_6H_{12}O_6$ formula, though structures vary

- Glucose
- Fructose (fruit sugar, the sweetest of all the sugars)
- Galactose (seen only as part of the disaccharide lactose)
- Note that the structure of these monosaccharides is very much like glucose; again, even in the simplified versions you see illustrated, you should be able to see that each has 6 carbons. All monosaccharides are 6-carbon molecules.

Disaccharides: two monosaccharides joined together

- Maltose = Glucose + Glucose
    - found in the body as starch chains are digested (see section on digestion below)
- Sucrose = Glucose + Fructose
    - common sugars (granulated sugar, brown sugar, corn syrup, etc.)
- Lactose = Glucose + Galactose
    - the sugar found in milk and other dairy products
- Recommendations are to ingest few kcals each day from concentrated sweets; recall the concept of discretionary kcals in the USDA Food Patterns. One regular 16-oz. soda has 8-10 teaspoons of sugar -- this could add up to over 300 kcals if you drank just 2 in a day!
    - Calculation practice: CALCULATE the kcals from sugar in a Starbucks Tall Chocolate Frappuccino that contains 52 grams (!) of sugar. Email fellow classmates to confer about how this calculation would be done and to check your answer.
    - Though there are still controversies regarding sugar, used in moderation, sugar intake is not harmful to health (See textbook section on Health Effects and Recommended Intakes of Sugars).
    - Highlight 4 addresses the issue of controversies surrounding carbohydrate intake

Polysaccharide: complex carbohydrate

- Poly, of course, means many, so we are talking about many glucose molecules in a long chain
- Examples:
    - glycogen: stored glucose (energy) in liver and muscles
    - starch: stored glucose (energy) in the plant

        - humans consume the starch in these plant products as a source of energy
    - fibers: the nondigestible polysaccharides in plant products (membranes, skins, seeds)
        - soluble fiber (note specific health benefits in textbook)
        - insoluble fiber (note specific health benefits in textbook)

The Carbohydrate Family: a summary (see Table 4-1)

Digestion of Carbohydrate

- As you review the following summary, refer to Fig. 4-8 in your text.
- Amylase, secreted from salivary glands, begins the chemical breakdown of starch
    - mouth: starch is broken down into small polysaccharides and maltose through the action of amylase
- NO action in the stomach (Why?? Note the reason in your text)
- Small intestines
    - pancreatic amylase continues the work of breaking down polysaccharide chains until they are disaccharides (maltose)
    - sucrose and lactose go through the digestive tract unchanged until they reach the small intestines
        - maltase, sucrase, and lactase, secreted by the intestinal cells, perform the final hydrolysis into the individual monosaccharide
- Monosaccharide is absorbed
    - fructose and galactose must go to the liver after absorption, where they will be converted to glucose (cells must have glucose as the energy source)
    - you may find the section on Lactose Intolerance (p. 105) interesting; or read about the condition at this National Digestive Diseases Information Clearinghouse website (http://digestive.niddk.nih.gov/ddiseases/pubs/lactoseintolerance/index.htm), maintained by the National Institutes of Health.
- Fiber travels through the GI tract virtually unchanged
    - remember, this is the definition of fiber: the non-digestible part of the plant product (bonds cannot be broken by human enzymes)
- The Power Point slides that accompany this lecture have some good illustrations of this process

The Constancy of Blood Glucose

- Homeostatic level of blood glucose is 70-100 mg/dl
- Use the illustration in Fig. 4-10 of your textbook and follow this outline
    - Fed State (your texbook doesn't use this terminology, but I do, so get used to thinking of the period just after eating as the "***fed state***")
        - increased blood glucose levels after eating foods containing carbohydrate

        - insulin secretion by the pancreas
        - glycogen synthesis (storing glucose in liver and muscles)
            - the liver is responsible for getting blood glucose levels back to the healthy state so, in times of excess, it will continue to take glucose out of the bloodstream until that level is reached
            - the extra glucose can then be stored for use later
        - fat synthesis
            - if there is still an excess of glucose over what can be stored as glycogen, the liver will now convert glucose to triglyceride and send it to the fat cells for storage!
    - Fasting State (***"fasting state"*** is the normal - or homeostatic - period between meals; in other words, you are not eating right now)
        - decreased blood glucose levels as body continues to "burn" the glucose that is in the bloodstream
        - glucagon secretion by the pancreas
            - glucose is put into bloodstream as ***liver*** glycogen breaks down
                - the muscles do not contribute any of their stored glucose into the bloodstream; that stored energy is for the work of the muscle itself
        - fat is drawn from storage as a fuel source as well
        - Epinephrine can also stimulate the release of glycogen during stress or during exercise
- The Power Point slides that accompany this lecture have some good illustrations of this process
- What happens when blood glucose regulation fails?
    - Read about "Basic Diabetes Information" from the American Diabetes Association (www.diabetes.org). When you finish with this page, see all the other information provided on diabetes.
    - Another good website for an online study of diabetes is the Joslin Diabetes Center (www.joslin.org).

Adding FIBER to your diet

- Most Americans get around 13 grams of fiber per day, whereas the recommendations are from 20-35 grams (depending on the source).
- Read the section in your textbook on the Health Effects and Recommended Intakes of Starch and Fibers. How can you get more fiber in your diet?
    - Choose whole grain or mixed grain breads and cereals.
    - Substitute fiber-rich ingredients in your favorite recipes, such as:
        - whole grain flours or oatmeal
        - legumes
        - whole wheat pasta