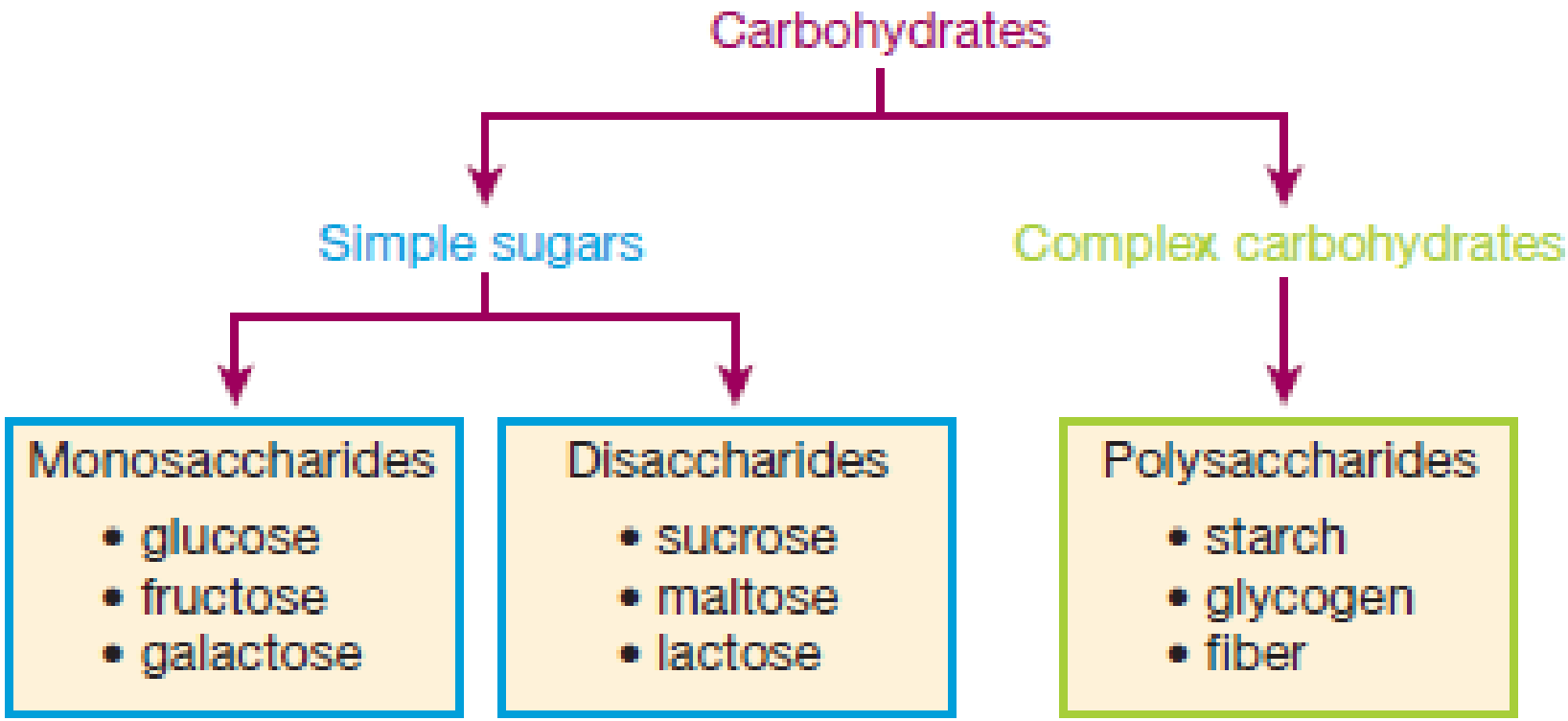
Chapter 2 : Carbohydrates

Introduction

- Provides majority of calories in human body
- Not only in sugars and breads

Classifications



Dietary Fibers

- A group name for polysaccharides that cannot be digested by human enzymes.
- Classified to :
  - Soluble
  - Insoluble

Dietary Fibers

- ✓It is not digested by human enzymes
- ✓May trap macronutrients eaten at the same time
- ✓Prevent them from being absorbed

Fiber does not provide any calories

Dietary Fibers

- **Soluble fibers** are fermented by bacteria in the colon to produce carbon dioxide, methane, hydrogen, and short-chain fatty acids which serve as a source of energy (calories) for the mucosal lining of the colon.

BOX 2.1 TYPES, PHYSIOLOGICAL EFFECTS, AND SOURCES OF SOLUBLE AND INSOLUBLE FIBER

Soluble Fiber (More Fermentable)	Insoluble Fiber (Less Fermentable)
Types	**Types**
Pectin	Cellulose
Some hemicelluloses	Many hemicelluloses
Vegetable gums	Lignans
Psyllium	Psyllium
Mucilages	
Mixed with water	**Mixed with water**
Dissolve to form a viscous gel	Do not dissolve but act like a sponge in the intestine to soak up water
Physiologic effects	**Physiologic effects**
Slow gastric emptying time	Increase stool bulk
Promote a feeling of fullness	Promote laxation
Delay and blunt the rise in serum glucose after eating	Prevent constipation
Lower serum cholesterol, possibly by trapping cholesterol which increases cholesterol excretion	
Best Sources	**Best Sources**
Dried peas and beans	Whole wheat bread and cereals
Lentils	Certain fruits and vegetables
Oats	
Certain fruits and vegetables	

Dietary Fibers

Fiber Content of Selected Foods

Food Source	Soluble Fiber (g)	Insoluble Fiber (g)	Total Fiber (g)
Grains			
Barley, ½ cup cooked	1	3	4
Oatmeal, ½ cup cooked	1	1	2
Popcorn, popped, 3 cups	0.1	1.9	2
Puffed wheat cereal, 1 cup	0.5	0.5	1.0
Spaghetti, white, ½ cup	0.4	0.5	0.9
Spaghetti, whole wheat, ½ cup	0.6	2.1	2.7
White bread, 1 slice	0.3	0.3	0.6
Whole wheat, 1 slice	0.3	1.2	1.5
Dried Peas and Beans (½ Cup Cooked)			
Black beans	2.4	3.7	6.1
Black-eyed peas	0.5	4.2	4.7
Kidney beans, light red	2	5.9	7.9
Lima beans	3.5	3	6.5
Pinto beans	1.4	4.7	6.1
Lentils	0.6	4.6	5.2

(table continues on page 23)

Dietary Fibers

Fiber Content of Selected Foods (continued)

Food Source	Soluble Fiber (g)	Insoluble Fiber (g)	Total Fiber (g)
Fruit (1 Medium)			
Apple	1	3	4
Bananas	1	2	3
Blackberries (½ cup)	1	3	4
Orange	2	0–1	2–3
Pears	2	2	4
Prunes (¼ cup)	1.5	1.5	3
Vegetables (½ Cup Cooked)			
Broccoli	1	0.5	1.5
Brussels sprouts	3	1.5	4.5
Carrots	1	1.5	2.5
Cauliflower	0.4	0.6	1.0
Corn, canned	0.2	1.4	1.6
Okra, frozen	1	3.1	4.1
Peas, frozen	1.3	3.0	4.3

Sources of Carbohydrates

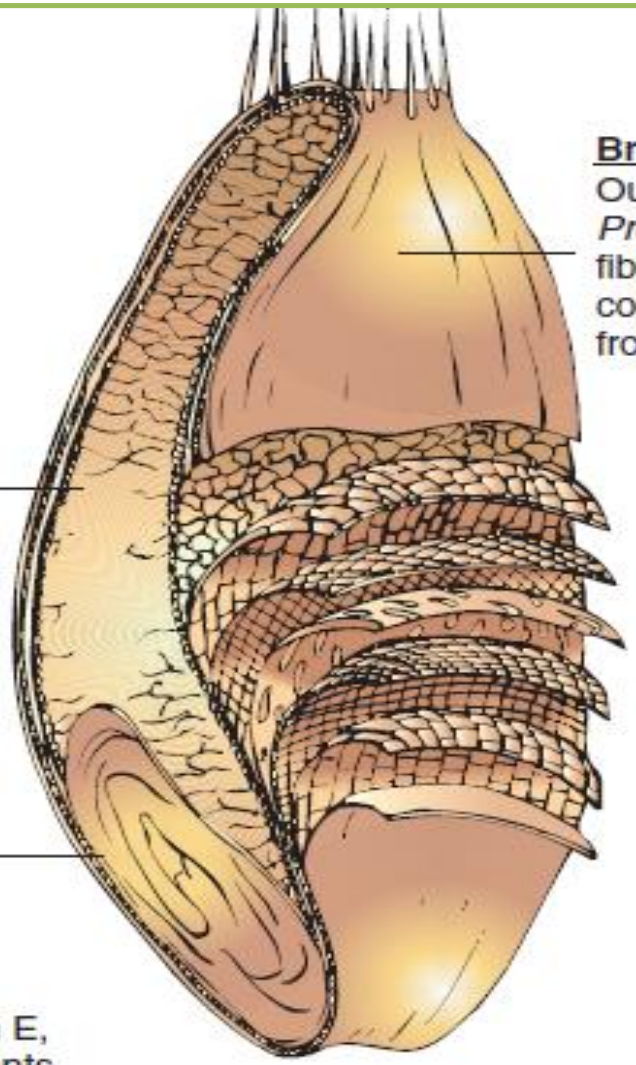
Grains

- Consists of:

1. Grains
   - (e.g., wheat, barley, oats, rye, corn, and rice)

2. Products made with flours from grains
   - (e.g., items made with wheat flour, such as bread, crackers, pasta, and tortillas)

Grains Classification



Bran
Outer layer that protects rest of kernel
Provides:
fiber, antioxidants, B vitamin, iron, zinc, copper, magnesium, and phytochemicals from sunlight, pests, water, and disease

Endosperm
Storage site for starch; main source of flour
Provides:
protein, starch, small amounts of vitamins, and trace minerals

Germ
Embryo that will sprout into another plant if fertilized
Provides:
B vitamins, some protein, healthy fat, vitamin E, minerals, antioxidants, and phytochemicals

Refined grains:
- made only from endosperm
- are enriched with thiamin, riboflavin, niacin, and iron lost through processing
- are fortified with folic acid
- are inferior to whole grains in vitamin B_6, protein, pantothenic acid, vitamin E, fiber, phytochemicals

Enrichment

adding back certain nutrients (to specific levels) that were lost during processing.

Fortification

adding nutrients that are not naturally present in the food or were present in insignificant amounts.

Grains

- Each 1 ounce of grains have 15 grams CHO
- 1 ounce equivalence :
  - 1 slice of bread
  - ½ cup cereals / cooked rice / pasta

Vegetables

- A 1⁄2 cup serving of **“starchy”** vegetables provides 15 g CHO
  - Corn, Lentils ,Peas, Potato , Sweet potato
- The same amount of **“watery”** vegetables provides 5 g CHO
  - Asparagus ,Bean sprouts, Broccoli, Carrots, Green beans ,Greens, Okra, Tomato

Fruits

- All of the calories come from fruits, mostly as **fructose**
- Except : Avocado , olives , coconut
- a serving of fruit, defined as :
  - 3⁄4 cup of juice
  - 1 piece of fresh fruit
  - 1⁄2 cup of canned fruit
  - 1⁄4 cup of dried fruit
    - provides 15 g of carbohydrate and approximately 2 g fiber

QUICK BITE

The effect of processing on fiber content

	Fiber (g/serving)
Unpeeled fresh apple (1)	3.0
Peeled fresh apple (1)	1.9
Applesauce (½ cup)	1.5
Apple juice (¾ cup)	Negligible

Milk

- One cup of milk, regardless of the fat content, provides 12 g of carbohydrate in the form of lactose.
- Flavored milk, yogurt and ice cream have more added sugars !!

CHO and Fiber Requirements

- CHO :
  - 45% to 65% of total calories
- Total Fibers:
  - 14 g/1000 calories or 25 g/day for women and 38 g/day for men
- Sugar :
  - a maximal level of 25% of total calories or less from added sugars is recommended

Functions of Carbohydrates

1. **Glucose for Energy**

- Glucose is burned more efficiently and more completely than either protein or fat.
- The brain is totally dependent on glucose for energy.
- All digestible carbohydrates provide 4 cal/g consumed.

2. **Protein Sparing**

- Consuming adequate carbohydrate to meet energy needs has the effect of "sparing protein" from being used for energy, leaving it available to do its special functions.

- Especially whenever protein **needs are increased** such as ….

3. **Preventing Ketosis**

- Without adequate glucose, fat oxidation prematurely stops at the intermediate step of **ketone body** formation

3. **Preventing Ketosis**

- An increased production of ketone bodies and their accumulation in the bloodstream causes:
  - Nausea
  - Fatigue
  - Loss of appetite
  - Ketoacidosis

4. **Using Glucose to Make Other Compounds**

- 1. **Glycogen**
- **2. Nonessential Amino Acids**
- 3. **Carbohydrate-Containing Compounds**
  - Ribose (in DNA, RNA)
  - keratin sulfate (in fingernails)
  - hyaluronic acid (found in the fluid that lubricates the joints)

4. **Using Glucose to Make Other Compounds**

- **4. Fat :**

  After energy needs are met glycogen stores are saturated, and other specific compounds are made

- converted by liver cells to triglycerides and stored in the body's fat tissue.

CHO in Health Promotion

Concentrate on Fibers and Whole Grains

Whole Grains

- To relieve or prevent constipation
- Provide fiber and a “whole package” of healthful components, such as essential fatty acids, antioxidants, vitamins, minerals, and phytochemicals

Whole Grains

The Dietary Guidelines recommend that adults and children consume at least one-half of their grain servings of whole grains

Proof

- People who eat three or more servings of whole grains daily:
  - have a 20% to 30% lower risk of atherosclerotic cardiovascular disease
  - are less likely to develop insulin resistance and metabolic syndrome
  - improved body weight management

Whole Grains and Weight

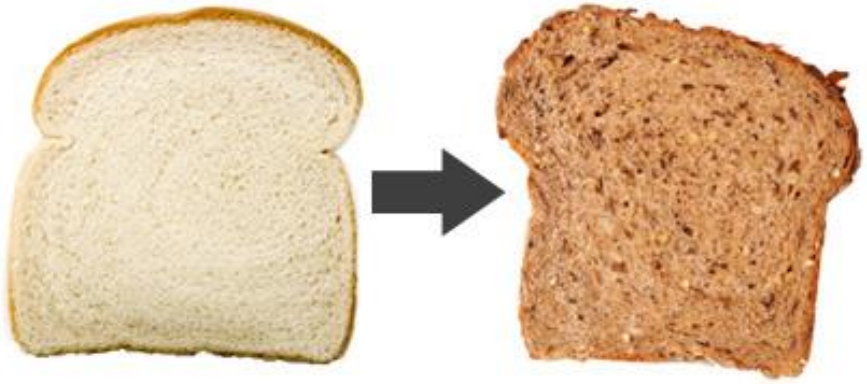
- They are generally less calorically dense than refined foods
- High in bulk
  - They may take longer to consume; and prolong gastric emptying, delaying the return of hunger

Reflect on yesterday to calculate your fiber intake.

1. Multiply total number of servings of fruit and vegetables per day by 1.5 grams of fiber. **Example:** 5 servings x 1.5 = 7.5 grams of fiber Yesterday, I had _____ servings x 1.5 = _____ grams of fiber from fruits and vegetables
2. Multiply servings of refined grains by 1.0 grams of fiber. Refined grains include white flour, white bread, white rice or pasta and cereals such as cheerios, frosted flakes, corn flakes. **Example:** 4 servings x 1.0 = 4 grams of fiber Yesterday, I had _____ servings x 1.0 grams of fiber = _____ grams of fiber from refined grains.
3. Multiply servings of whole grains by 2.5 grams of fiber. Whole grains are whole wheat breads, flours, cereals, brown rice or pastas. **Example:** 3 servings x 2.5 = 7.5 grams of fiber Yesterday, I had _____ servings x 2.5 grams of fiber = _____ grams of fiber from whole grains.
4. Multiply servings of high fiber foods by 5 grams of fiber. High fiber foods may include beans or high fiber cereal. **Example**: _ cup of black beans or 1 high fiber serving x 5 = 5 grams of fiber Yesterday, I had _____ servings x 5 grams of fiber = _____ grams of fiber from high fiber foods.
TOTAL: _____grams of fiber for day *Add up your total grams of fiber from each category, #1-4.* *This is an estimate of how many grams of fiber you are getting per day.*

Ways to increase fiber intake ???

- whole wheat bread
- half of the white flour in pancakes, waffles, muffins, quick breads, and cookies with whole wheat flour or oats



- whole wheat bread or cracker crumbs as a coating or breading for meat, fish, and poultry

Limit Added Sugars

High added sugar foods are likely to be **"empty calories"** !!!

- Displace more nutritious foods
- Calorie intake will be excessive (if empty calorie foods are added to the diet)

WAYS TO LIMIT ADDED SUGARS

- **Cut Back or Eliminate Sugar-Sweetened Soft Drinks**
  - every can of soft drink provides 9 to 10 teaspoons of added sugar
- **Rely on Natural Sugars in Fruit to Satisfy a "Sweet Tooth"**
- **Cut Sugar in Home-Baked Products, If Possible**
- **Read Labels**
  - Corn syrup, Dextrose, Fructose, Fruit juice concentrate, HFCS, Honey, Molasses
- **Consider Using Sugar Alternatives ????**

Sugar Alternatives

- **Sugar Alcohols**
  - (e.g., sorbitol, mannitol, xylitol)

- **Nonnutritive Sweeteners**

Sugar Alcohols

- Small amounts are found in some fruits and berries
- Commercially synthesized and used as alternative sweeteners

- low-calorie sweeteners → absorbed slowly and incompletely → produce a smaller effect on blood glucose levels and insulin secretion

Sugar Alcohols

- Approved to use in
  - candies, chewing gum, jams and jellies, baked goods, and frozen confections
- Offer sweetness without promoting cavities
- Some people experience a laxative effect.

Nonnutritive Sweeteners

- Calorie free
- Hundreds to thousands of times sweeter than sugar
- They do not raise **blood glucose levels**

Nonnutritive Sweeteners Approved for Use in the United States

Sweetener	Sweetness (Sucrose = 1)	Taste Characteristics	Uses	Comments
Saccharin (Sweet Twin™, Sweet 'n Low™)	200–700	Persistent aftertaste; bitter at high concentrations	Soft drinks, assorted foods, tabletop sweetener	Potential (weak) carcinogen; the FDA has officially withdrawn its proposed ban so warning labels no longer required
Aspartame (Nutrasweet™, Equal™, Spoonful™)	180	Similar to sucrose; no aftertaste	Tabletop sweeteners, dry beverage mixes, chewing gum, beverages, confections, fruit spreads, toppings, and fillings	Made from the amino acids aspartic acid and phenylalanine; people with PKU must avoid aspartame

saccharin

Acesulfame K (Sunette™, Sweet One™)	130–200	Bitter aftertaste like saccharin	Tabletop sweeteners, dry beverage mixes, and chewing gum	Often mixed with other sweeteners to synergize the sweetness and minimize the aftertaste Not digested; excreted unchanged in the urine
Sucralose (Splenda™)	600	Maintains flavor even at high temperatures	Soft drinks, baked goods, chewing gums, and tabletop sweeteners	Poorly absorbed; excreted unchanged in the feces
Neotame	8000	Clean, sugar-like taste; enhances flavors of other ingredients	Under review	Made from aspartic acid and phenylalanine but is not metabolized to phenylalanine so a warning label is not required Has the potential to replace both sugar and HFCS

acesulfame
sucralose
neotame

Risks and Benefits of Nonnutritive Sweeteners

Weight management ???????!!!!

Safety

The ADI of aspartame is 50 mg/kg of body weight

** average intake is only 3 mg/kg !

- For most adults, nonnutritive sweeteners are safe
- For pregnant women and children (the approved ones only: within the intake guidelines)