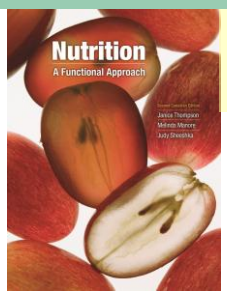
Nutrition: A Functional Approach

Janice Thompson Melinda Manore Judy Sheeshka

4



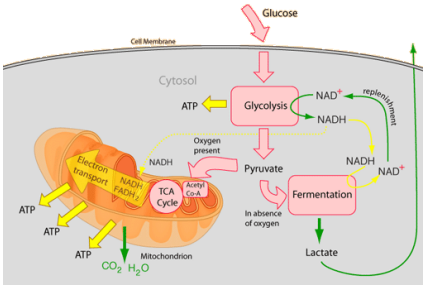
Carbohydrates: Bountiful Sources of Energy and Nutrients

The Role of Carbohydrates

Energy

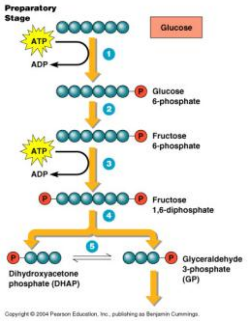
- Each gram of carbohydrate = 4 kcal
- Red blood cells rely only on glucose for their energy supply
- Both carbohydrates and fats supply energy for daily activities
- Glucose is especially important for energy during intense exercise

The Role of Carbohydrates



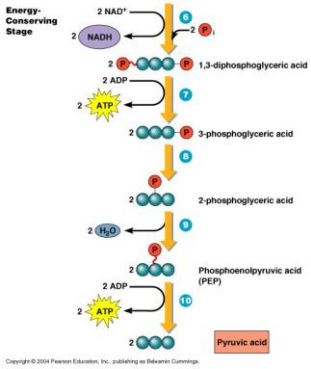
http://hyperphysics.phy-astr.gsu.edu/hbase/biology/celres.html

The Role of Carbohydrates

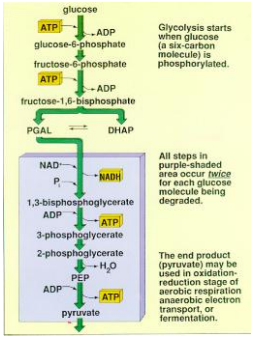


http://classes.midlandstech.com/carterp/Courses/bio225/chap05/ss4.htm

The Role of Carbohydrates



The Role of Carbohydrates



http://hyperphysics.phy-astr.gsu.edu/hbase/biology/celres.html

Carbohydrates and Exercise

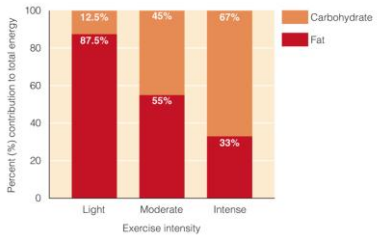


Figure 4.8 Amounts of carbohydrate and fat used during light, moderate, and intense exercise. (Adapted from J. A. Romijn, E. F. Coyle, L. S. Sidossis, A. Gastaldelli, J. F. Horowitz, E. Endert, and R. R. Wolfe, 1993, Regulation of endogenous fat and carbohydrate metabolism in relation to exercise intensity and duration, *Am. J. Physiol.* 265 [Endocrinol. Metab. 28]:E380–E391.)

Carbohydrates and Exercise

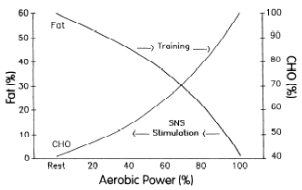
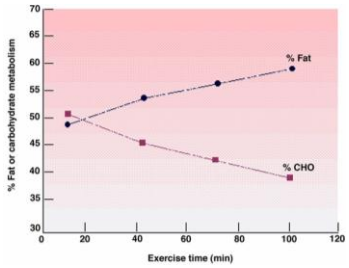


FIG. 1. Relative increase in energy derived from carbohydrate (CHO) utilization and decline in energy from oxidation of lipid (fat) utilization as function of relative power output. At crossover point, increments in relative exercise intensity result in increasingly greater dependence on CHO and less dependence on fat. Even though on absolute scale training results in rightward curve shifts, on relative basis training probably has minimal effects on curves relative to aerobic power. See text for explanation. SNS, sympathetic nervous system.

(Brooks, G.A., and J. Mercier. Balance of carbohydrate and lipid utilization during exercise: the "crossover" concept. Journal of Applied Physiology. 76(6): 2253-2261, 1994.)

Carbohydrates and Exercise



The Role of Carbohydrates

Energy

- Brain prefers glucose
- Sufficient energy from carbohydrates prevents production of ketones as an alternate energy source
- Excessive ketones can result in high blood acidity and ketoacidosis
- High blood acidity damages body tissues

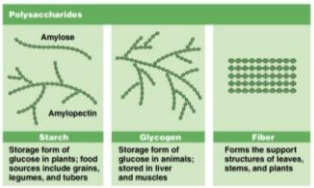
The Role of Carbohydrates

Energy

- Carbohydrates spare proteins by preventing their breakdown as an energy source
- When carbohydrate intake is low, proteins are used for gluconeogenesis – the production of new glucose
- Relying on body protein as a source of energy (glucose) can, over time, lead to organ damage

The Role of Carbohydrates

Fibre is a complex CHO



The Role of Carbohydrates

Fibre is our friend

The Role of Carbohydrates

Insoluble Fibre:

- Found in the skins of vegetables and fruit, bran portion of whole grains
- Helps promote regularity and a healthy digestive system.

The Role of Carbohydrates

Soluble Fibre:

- Found in some vegetables, fruit and legumes like dried beans and peas
- Soluble fibre thickens and becomes gel like when water is added.
- Can help slow the digestion of food.
- Eating high fibre foods may help you feel full for a longer time, which helps with appetite and weight control.

The Role of Carbohydrates

Fibre (cont.)

- May reduce the risk of colon cancer
  - Can bind cancer-causing substances and speed their elimination
- May reduce the risk of heart disease
  - Blocks or delays the absorption of cholesterol
- May lower the risk of T2D
  - Soluble fibre slows the release of glucose into the blood

The Role of Carbohydrates

Fibre (cont.)

- May enhance weight loss
  - Feel more full
- Promotes regular bowel movements
  - Insoluble fibre attracts and holds onto water in the intestine, decreases transit time through the intestine
- Help prevents hemorrhoids, constipation, and diverticulosis
  - Keeps stools moist and soft
  - Give GI muscles something to "push on"

The Role of Carbohydrates

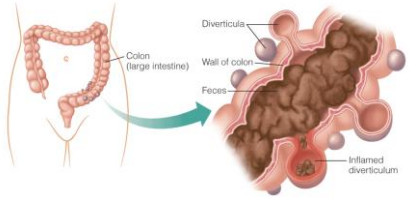


Figure 4.9 Diverticulosis occurs when bulging pockets form in the wall of the colon. These pockets can become infected and inflamed, causing a painful condition called diverticulitis.

How Much Carbohydrate?

Recommended Dietary Allowance (RDA) is 130 grams/day just to supply the brain with glucose.

45-65% of daily calorie intake should be in the form of carbohydrates (AMDR).

Added sugar intake should be 25% or less of total energy intake.

Carbohydrate intake from CCHS data:

- Adults: 50.1% of energy from carbohydrates
- Children: 55.4% of energy from carbohydrates

How Much Carbohydrate

Simple sugars account for ~25% of the CHO calories (Statistics Canada, 2003).

Added Sugars: sugars and syrups added to foods during processing or preparation.

- White sugar
- Brown sugar
- Maple syrup
- Corn sweeteners – dextrose, high fructose corn syrup, glucose syrup
- Honey

Added Sugar

Added Sugars

Nutrition Facts

Serving Size: 1 Container (170g)
Calories 190
Fat Cal 0
*Percent Daily Values (DV) are based on a 2,000 calorie diet.

Amount/Serving	%DV*	Amount/Serving	%DV*
Total Fat 0g	0%	**Potassium** 490mg	14%
Saturated Fat 0g	0%	**Total Carbohydrate** 34g	11%
Trans Fat 0g		Dietary Fiber 0g	0%
Cholesterol 15mg	5%	Sugars 29g	
Sodium 140mg	6%	**Protein** 12g	24%

Vitamin A 0% • Vitamin C 0% • Calcium 40% • Iron 0%
Vitamin D 15% • Riboflavin 40% • Phosphorus 30%

INGREDIENTS: CULTURED GRADE A NON FAT MILK, WATER, STRAWBERRIES, SUGAR, FRUCTOSE, MILK PROTEIN CONCENTRATE, CONTAINS LESS THAN 1% OF MALTODEXTRIN, MODIFIED CORN STARCH, MODIFIED FOOD STARCH, NATURAL FLAVORS, CARRAGEENAN, CARMINE AND BLACK CARROT JUICE CONCENTRATE (FOR COLOR), SODIUM CITRATE, POTASSIUM SORBATE (TO MAINTAIN FRESHNESS), MALIC ACID, VITAMIN D3. DISTRIBUTED BY THE DANNON COMPANY, INC. WHITE PLAINS, NY 10603. CONTAINS THE ACTIVE CULTURES ***L. BULGARICUS, S. THERMOPHILUS* AND *BIFIDOBACTERIUM LACTIS* DN 173-010** (BIFIDUS REGULARIS®)

Foods with added sugars have lower levels of vitamins and minerals than most natural foods that contain sugar.

Simple vs. Complex Carbs

Diets high in simple sugars:

- Can cause dental problems such as cavities and gum disease
- Are associated with increased levels of "bad cholesterol"
- Are associated with decreased levels of "good cholesterol"
- Have no link to hyperactivity
- May contribute to obesity – Controversial

Simple vs. Complex Carbohydrates

Table 4.3 Terms Used to Describe Grains and Cereals on Nutrition Labels

Term	Definition
Brown bread	Bread coloured by the use of whole wheat flour, graham flour, bran, molasses or caramel
Enriched white bread	Bread made using only enriched wheat flour; contains thiamin, riboflavin, niacin, folic acid, iron; may contain vitamin B_6, pantothenic acid, magnesium, calcium
Whole wheat bread	Bread containing not less than 60% whole wheat flour in relation to the total amount of flour used
Whole wheat flour or entire wheat flour	Bread containing not less than 95% of the natural constituents of the wheat berry
Graham flour	Flour with additional bran and other constituents of the wheat berry
Cracked wheat flour	Flour containing the natural constituents in the proportions found in the wheat used.

Source: Adapted from Canadian Food Inspection Agency, Guide to Food Labelling and Advertising, 9.8 Grain and Bakery Products, http://www.inspection.gc.ca/english/fssa/labet/guide/ch9ae.shtml#9.8 accessed February 2008.

Simple vs. Complex Carbs

The Adequate Intake (AI) of fibre is 14 grams for every 1000 kcal in the diet; for men,

- 38 grams for men, 24 grams for women

Average daily fibre intakes for adults aged 19 and over are 19.1 g for men and 15.6 g for women.

Eating whole grain foods, fruits, vegetables, and legumes daily will increase your fibre intake.

Fibre in Foods

Table 4.4 Fibre Content of Common Foods

Food	Fibre Content (grams)
Breads and Cereals:	
Bagel, 1 each (diam. 7.5 cm)	2
French bread, 1 small slice	2
White bread, 1 slice	1
Pumpernickel bread, 1 small slice	2
Whole wheat bread, 1 slice	2
Oatmeal, quick, 250 mL (1 cup)	4
Cheerios, 250 mL (1 cup)	1
Corn Flakes, 300 mL (1 ½ cup)	1
Lucky Charms, 250 mL (1 cup)	1
Fruits and Juices:	
Apple, 1 small, with peel	3
Apple juice, 250 mL (8 fl. oz.)	< 1
Blackberries, 250 mL (1 cup)	8
Banana, 1 medium	2
Orange, 1 small, peeled	3
Orange juice, 250 mL (8 fl. oz.), from concentrate	< 1
Pear, 1 medium, with skin	5
Vegetables:	
Asparagus, cooked, 6 spears	2
Broccoli, raw, chopped, 250 mL (1 cup)	3
Broccoli, cooked, chopped, 250 mL (1 cup)	5
Cabbage, raw, chopped, 250 mL (1 cup)	1
Collard greens, cooked, 125 mL (½ cup)	2
Corn, canned, whole kernel, 125 mL (½ cup)	6
Kale, cooked, 125 mL (½ cup)	1
Lettuce, iceberg, shredded, 250 mL (1 cup)	1
Legumes:	
Black beans, cooked, 125 mL (½ cup)	7
Lima beans, cooked, 125 mL (½ cup)	7
Navy beans, cooked, 125 mL (½ cup)	9
Kidney beans, cooked, 125 mL (½ cup)	9
Lentils, cooked, 125 mL (½ cup)	5

Source: U.S. Department of Agriculture, Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 16, 2004. Nutrient Data Laboratory Homepage, www.nal.usda.gov/fnic/foodcomp. Values obtained from the USDA Nutrient Database for Standard Reference, Release 16.

Note: The Adequate Intake for fibre is 25 grams per day for women and 38 grams per day for men.

Drink Water!

Alternative Sweeteners

Nutritive sweeteners

- Contain 4 kcal energy per gram
- Sucrose, fructose, honey, brown sugar, sugar alcohols

Non-nutritive (alternative) sweeteners

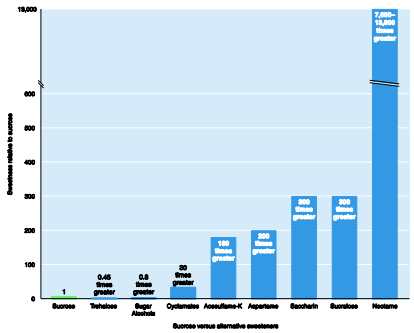
- Provide little or no energy
- Do not promote tooth decay

Alternative Sweeteners

Acceptable Daily Intakes (ADI) have been established by Health Canada for:

- saccharin
- cyclamates
- acesulfame-K
- aspartame
- sucralose
- neotame

Alternative Sweeteners



Alternative Sweeteners

Table 4.6 Acceptable Daily Intake (ADI) Levels of Alternative Sweeteners as Set By Health Canada

Sweetener	ADI (mg per kg body weight per day)
Saccharin*	5
Cyclamates*	11
Acesulfame-K	15
Aspartame	40
Sucralose	15
Neotame	2

*Not recommended for pregnant or breastfeeding women.

Health Disorders

Three health disorders related to carbohydrate metabolism are:

- Diabetes
- Hypoglycemia
- Lactose intolerance

Diabetes

Diabetes

- Inability to regulate blood glucose levels
- Three types:
  - Type 1 diabetes
  - Type 2 diabetes
  - Gestational diabetes
- Untreated diabetes can cause nerve damage, kidney damage, blindness, and can be fatal
- 7th major cause of death in Canada
- More than 2 million Canadian have diabetes

Diabetes

Type 1 diabetes

- Accounts for 10% of all cases
- Patients do not produce enough insulin
- Causes hyperglycemia – high blood sugar (glucose)
- Requires insulin injections
- Monitor blood glucose with a glucometer
- May be an autoimmune disease

Diabetes

Type 2 diabetes

- Most diabetics (90%) have Type 2 diabetes
- Body cells are insensitive or unresponsive to insulin
- Excess insulin is often produced
- Pancreas becomes incapable of secreting excessive amounts of insulin
- Causes hyperglycemia because cells cannot take in the glucose from the blood

Diabetes

Type 2 diabetes

- Cause is unclear but genetics, obesity, and physical inactivity play a role
- Treated with diet, exercise, and possibly oral medications
- Healthy lifestyle choices may prevent or delay onset of type 2 diabetes

Diabetes

Table 4.8 Symptoms of Type 1 and Type 2 Diabetes

Type 1 Diabetes	Type 2 Diabetes*
Frequent urination	Any of the type 1 symptoms
Unusual thirst	Frequent infections
Extreme hunger	Blurred vision
Unusual weight loss	Cuts or bruises that are slow to heal
Extreme fatigue	Tingling or numbness in the hands or feet
Irritability	Recurring skin, gum, or bladder infections

Source: Adapted from the American Diabetes Association, Diabetes Symptoms, www.diabetes.org (accessed December 2003).
*Some people with type 2 diabetes experience no symptoms.

Diabetes

Most common symptoms:

Polyuria: The need to urinate frequently
Polydipsia: Increased thirst & fluid intake
Polyphagia: Increased appetite

Diabetes

Prediabetes (impaired fasting glucose)

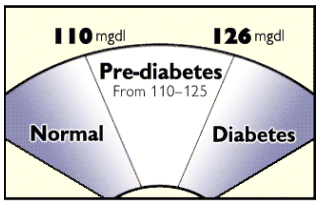
- Condition in which blood glucose levels are higher than normal but not high enough to be classified as full-blown diabetes.

Metabolic Syndrome

- Characterized by abnormal glucose and insulin levels, high blood pressure, imbalance of blood fats, and excess fat around waistline.
- Strongly linked to diabetes and heart disease.

Insulin

Diabetes



Fasting Plasma Glucose Test

http://diabetics-ways.blogspot.ca/2009/10/how-to-diagnose-diabetes-diagnosis.html

Diabetes

Lifestyle choices

- May need to eat less CHO, more fat and protein
- Avoid alcohol
- Maintain health body weight
- Eat a balanced diet
- Exercise!

"What fits your busy schedule better, exercising one hour a day or being dead 24 hours a day?"

http://diabetics-ways.blogspot.ca/2009/10/how-to-diagnose-diabetes-diagnosis.html

Hypoglycemia

Hypoglycemia

- Low blood sugar (glucose)
  - Inject too much insulin
  - Fail to eat CHO after exercise
- Reactive hypoglycemia results when too much insulin is produced after a meal
  - Causes shakiness, sweating, anxiety, headaches, weakness, rapid or irregular heart beat
  - Recommendation: eat smaller meals more often

Hypoglycemia

- Fasting hypoglycemia results when too much insulin is produced even when the patient has not eaten

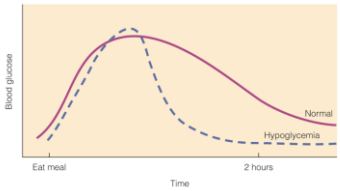


Figure 4.13 Changes in blood glucose after a meal for people with hypoglycemia and without hypoglycemia (normal).

Lactose Intolerance

Lactose intolerance

- Insufficient lactase production causes an inability to digest lactose found in dairy products
- Symptoms include intestinal gas, bloating, nausea, cramping, diarrhea

Lactose Intolerance

Lactose intolerance

- Some lactose intolerant people can digest small amounts of dairy products, especially aged cheese and yogurts
- Lactose intolerant people may need to find appropriate sources of calcium:
  - Low lactose milk
  - Plant-based milk (e.g. soy)
  - Calcium-fortified orange juice