Chapter 18

Nutrition and Metabolism
Objectives

• Define and contrast catabolism and anabolism
• Describe the metabolic roles of carbohydrates, fats, proteins, vitamins, and minerals
• Define basic metabolic rate and list some factors that affect it
Objectives

• Describe three disorders associated with eating or metabolism
• Discuss the physiological mechanisms that regulate body temperature
Definitions

• Nutrition—food, vitamins, and minerals that are ingested and assimilated into the body

• Metabolism—process of using food molecules as energy sources and as building blocks for our own molecules
Definitions

• Catabolism—process that breaks food molecules down, releasing their stored energy; oxygen used in catabolism
• Anabolism—process that builds food molecules into complex chemical compounds
Metabolic Function of the Liver

• Processes blood immediately after it leaves the gastrointestinal tract
  – Helps maintain normal blood glucose level
  – Site of protein and fat metabolism
  – Removes toxins from the blood
  – Synthesizes several kinds of protein compounds
Nutrient Metabolism

- Carbohydrate metabolism
  - Carbohydrates are the preferred energy food of the body
  - Three series of chemical reactions that occur in a precise sequence make up the process of glucose metabolism
    - Glycolysis—occurs in cytoplasm of the cell
      - Anaerobic process (uses no oxygen)
      - Changes glucose to pyruvic acid, which is then converted into acetyl CoA
      - Yields small amount of energy (transferred to ATP)
Nutrient Metabolism

• Citric acid (Krebs) cycle—occurs in the mitochondria
  – Aerobic process (requires oxygen)
  – Changes acetyl CoA to carbon dioxide
  – Yields small amount of energy
  – Most energy leaving the citric acid cycle is in the form of high-energy electrons

• Electron transport system—occurs in the mitochondria
  – Transfers energy from high-energy electrons (from citric acid cycle) to ATP molecules
  – ATP serves as direct source of energy for cells
Nutrient Metabolism

• Carbohydrate metabolism (cont’d)
  – Energy transferred to ATP differs from energy in food molecules
    • Not stored; released almost instantly
    • Can be used directly to do cellular work
  – Carbohydrates primarily catabolized for energy, but small amounts anabolized by glycogenesis (series of chemical reactions that changes glucose to glycogen—occurs mainly in liver cells where glycogen is stored)
• Carbohydrate metabolism (cont’d)
  – Blood glucose (imprecisely, blood sugar)—amount of glucose in blood
    • Normally stays between about 80 and 110 mg per 100 mL of blood during fasting
    • Insulin accelerates the movement of glucose out of the blood into cells, therefore decreases blood glucose and increases glucose catabolism
Nutrient Metabolism

• Fat metabolism
  – Fats are primarily an energy food
  – Converted to glucose by catabolism
  – Excess fat is anabolized to form adipose tissue

• Protein metabolism
  – Proteins are catabolized for energy only after carbohydrate and fat stores are depleted
  – Gluconeogenesis breaks apart amino acids to convert them to glucose
Vitamins and Minerals

- Vitamins—organic molecules that are needed in small amounts for normal metabolism (Table 18-2)
  - Avitaminosis—deficiency of a vitamin
    - Can lead to severe metabolic problems
    - Avitaminosis C can lead to scurvy
  - Hypervitaminosis—excess of a vitamin
    - Can be just as serious as avitaminosis
    - May be chronic or acute
Vitamins and Minerals

- Minerals—inorganic molecules found naturally in the earth
  - Required by the body for normal function, including nerve conduction (Table 18-3)
  - Can attach to enzymes to facilitate their work
Metabolic Rates

• Basal metabolic rate (BMR)—rate of metabolism when a person is lying down, is awake, is not digesting food, and the environment is comfortably warm

• Total metabolic rate (TMR)—the total amounts of energy, expressed in calories, used by the body per day
Metabolic and Eating Disorders

• Disruption or imbalance of metabolism caused by several different factors
  – Inborn errors of metabolism—genetic conditions involving deficient or abnormal metabolic enzymes
  – Some metabolic disorders are complications of other conditions
    • Hormonal imbalances
Metabolic and Eating Disorders

• Eating disorders
  – Anorexia nervosa—characterized by chronic refusal to eat
  – Bulimia—an alternating pattern of craving of food followed by a period of self-denial; in bulimarexia, the self-denial triggers self-induced vomiting
  – Obesity—abnormally high proportion of fat in the body; may be a symptom of an eating disorder
  – Protein-calorie malnutrition (PCM)—results from a deficiency of calories in general and proteins in particular
Metabolic and Eating Disorders

- Protein-calorie malnutrition (PCM)—results from a deficiency of calories in general and proteins in particular
  - May be a complication of a preexisting condition
  - Marasmus—type of advanced PCM caused by an overall lack of calories and protein, characterized by tissue wasting and fluid and electrolyte imbalances
  - Kwashiorkor—type of advanced PCM caused by a lack of protein in the presence of sufficient calories; similar to marasmus but distinguished by ascites and flaking dermatitis
Body Temperature

• Hypothalamus—regulates the homeostasis of body temperature through a variety of processes
  – Blood flow to the skin increases when body is overheated
  – Heat is lost through the skin by radiation, conduction, convection, evaporation
**Precapillary sphincters contract**

A. Blood flow increases to internal organs

**Heat Conservation**

B. Precapillary sphincters relax

Heat loss across epidermis

**Increased Heat Loss**
Body Temperature

- Abnormal body temperature can have serious physiological consequences
  - Fever (febrile state)—unusually high body temperature associated with systemic inflammation response
  - Malignant hyperthermia (MH)—inherited condition that causes increased body temperature (hyperthermia) and muscle rigidity when exposed to certain anesthetics
Body Temperature

- Heat exhaustion—results from loss of fluid as the body tries to cool itself; may be accompanied by heat cramps
- Heat stroke (sunstroke)—overheating of body resulting from failure of thermoregulatory mechanisms in a warm environment
Body Temperature

– Hypothermia—reduced body temperature resulting from failure of thermoregulatory mechanisms in a cold environment

– Frostbite—local tissue damage caused by extreme cold; may result in necrosis or gangrene