17

Nutrition, Metabolism, and Body Temperature

FOCUS: Vitamins and minerals are necessary for normal metabolism, and both must be ingested in the diet. Carbohydrate digestion, which breaks down carbohydrates into monosaccharides such as glucose, begins in the oral cavity and is completed in the small intestine. Protein digestion breaks down proteins into amino acids, and is accomplished in the stomach and small intestine. Lipids are digested into fatty acids and glycerol in the small intestine. Glucose is broken down in aerobic respiration to produce 38 ATP molecules or in anaerobic respiration to produce 2 ATP molecules. Amino acids, fatty acids, and glycerol can also be used to produce ATP. The energy in ATP is used for basal metabolism, physical activity and assimilation of food. As a byproduct of the chemical reactions of metabolism, heat is produced that contributes to body temperature.

CONTENT LEARNING ACTIVITY

Nutrition

"*The six major nutrients are carbohydrates, proteins, lipids, vitamins, minerals, and water.*"

Match these terms with the correct statement or definition:

Balanced diet
Essential nutrients
Kilocalorie
Nutrients

_____ 1. Chemicals taken into the body that provide energy and building blocks for new molecules.

_____ 2. Certain amino acids and fatty acids, most vitamins, minerals, water, and a minimum amount of carbohydrates are required.

_____ 3. Enough nutrients in the correct proportions to support normal body functions.

_____ 4. Energy that raises the temperature of 1000 g of water 1° C; used to express the amount of energy in food.

Carbohydrates

"*Carbohydrates include monosaccharides, disaccharides, and polysaccharides.*"

Match these terms with the correct statement or definition:

Cellulose	Glucose
Complex carbohydrate	Glycogen
Disaccharide	Starch
Fructose	Sucrose

_____ 1. The primary energy source for most cells.

_____ 2. Table sugar; a disaccharide of glucose and fructose.

_____ 3. Energy storage molecule produced from glucose in plants.

_____ 4. Energy storage molecule produced from glucose in animals.

_____ 5. Not digestible by humans; provides "roughage."

_____ 6. Category to which sucrose, lactose, and maltose belong.

_____ 7. Category to which starch, glycogen, and cellulose belong; polysaccharides.

Lipids

"*Approximately 95% of the lipids in the human diet are triacylglycerols.*"

Match these terms with the correct statement or definition:

Adipose	Triacylglycerol
Cholesterol	Saturated fat
Fatty acids	Unsaturated fat
Phospholipid	

_____ 1. Consists of three fatty acids bound to glycerol.

_____ 2. Have only single covalent bonds between their carbon atoms; solid at room temperature.

_____ 3. Have one or more double covalent bonds between carbon atoms; liquid at room temperature.

_____ 4. Excess triacylglycerols are stored in this tissue.

_____ 5. Released into blood from adipose tissue; used as an energy source.

_____ 6. Part of plasma membrane, modified to form bile salts and steroid hormones.

_____ 7. Part of plasma membrane; used to construct myelin sheaths around axons of nerve cells.

Triacylglycerols are often referred to as fats.

Proteins

"*Proteins are chains of amino acids.*"

Match these terms with the correct statement or definition:

Antibody	Enzyme
Buffer	Essential
Collagen	Incomplete
Complete	Nonessential

_____ 1. The eight amino acids that must be obtained in food.

_____ 2. Type of amino acids that can be manufactured by the body.

_____ 3. Food that contains all eight essential amino acids in the needed proportions.

_____ 4. Provides structural strength.

_____ 5. Regulates the rate of chemical reactions.

_____ 6. Protein that prevents changes in pH.

_____ 7. Part of the immune system.

Sources and Recommended Requirements

"*A variety of foods provide the recommended requirement of carbohydrates, lipids, and proteins.*"

A. Match these terms with the correct statement or definition:

Carbohydrate	Fat (saturated)
Cholesterol	Fat (unsaturated)
Essential fatty acid	Protein
Fat (all)	

_____ 1. About 125 to 175 g are needed every day; otherwise breakdown of muscle tissue or acidosis occurs.

_____ 2. Should account for 30% or less of the total kilocaloric intake.

_____ 3. Should contribute no more than 10% of total fat intake.

_____ 4. Should be limited to 300 mg or less per day.

_____ 5. Linoleic acid and alpha linolenic acid are examples.

_____ 6. Recommended daily consumption is 0.8 g/kilogram of body weight.

B. Match these terms with the correct statement or definition:

Carbohydrate
Cholesterol
Monounsaturated fat
Polyunsaturated fat
Protein (complete)
Protein (incomplete)
Saturated fat

_____ 1. Fructose in fruit, maltose in cereal, and lactose in milk.

_____ 2. Lipid in fats of meat, diary products, eggs, nuts, coconut oil, and palm oil.

_____ 3. Lipid in olive and peanut oil.

_____ 4. Lipid in fish, safflower, sunflower, and corn oils.

_____ 5. Protein in red meat, fish, poultry, milk, cheese, and eggs.

_____ 6. Protein in leafy green vegetables, grains, peas, and beans.

Vitamins

"*Vitamins exist in minute quantities in food and are essential to normal metabolism.*"

A. Match these terms with the correct statement or definition:

Antioxidant
Coenzyme
Essential vitamins
Fat-soluble vitamins
Free radical
Provitamins
Water-soluble vitamins

_____ 1. Cannot be produced by the body and must be obtained through the diet.

_____ 2. Portions of vitamins that can be assembled or modified by the body into functional vitamins; beta carotene is an example.

_____ 3. Chemical necessary for normal enzyme function.

_____ 4. Vitamins A, D, E, and K.

_____ 5. Vitamins that can be stored in the body.

_____ 6. B vitamins and vitamin C.

_____ 7. Beta carotene, vitamin C, and vitamin E; reduce the harmful effects of free radicals.

_____ 8. Atom or molecule with an unpaired electron in its outer orbital; damages molecules critical for normal cell function by attracting electrons from them.

B. Match these vitamins with the correct deficiency symptom:

Vitamin A
Vitamin B_{12}
Vitamin C
Vitamin D
Vitamin K

_____ 1. Scurvy; defective bone formation and poor wound healing.

_____ 2. Night blindness, retarded growth, and skin disorders.

_____ 3. Excessive bleeding resulting from retarded blood clotting.

_____ 4. Pernicious anemia and nervous system disorders.

_____ 5. Promotes calcium and phosphorus use; normal growth and bone and teeth formation.

Minerals

"*Minerals are inorganic nutrients necessary for normal metabolic functions.*"

Match these minerals with the correct function:

Calcium
Chlorine
Iodine
Iron
Phosphorus
Potassium
Sodium

_____ 1. Bone and teeth formation, blood clotting, muscle activity, and nerve function.

_____ 2. Osmotic pressure regulation; nerve and muscle function.

_____ 3. Blood acid-base balance; hydrochloric acid production in the stomach.

_____ 4. Bone and teeth formation; important in energy transfer (ATP); component of nucleic acids.

_____ 5. Component of hemoglobin; ATP production in electron transport system.

_____ 6. Thyroid hormone production; maintenance of normal metabolic rate.

_____ 7. Muscle and nerve function.

Metabolism

"*Metabolism is the sum total of all the chemical reactions that occur in the body.*"

A. Match these terms with the correct statement or definition:

Anabolism ATP
Catabolism

_____ 1. Energy-requiring processes by which small molecules are joined to form larger molecules.

_____ 2. Energy-releasing process by which large molecules are broken down into smaller molecules.

_____ 3. Process in which ATP and heat are produced.

_____ 4. The energy currency of the cell; releases energy used to drive chemical reactions.

_____ 5. Produced using the chemical energy in nutrient molecules.

B. Match these terms with the correct statement or definition:

Biochemical pathway DNA
Chemical signal End product

_____ 1. Series of chemical reactions that controls energy release during the breakdown of glucose, fatty acids, amino acids, and other molecules.

_____ 2. Determines what kinds of enzymes are produced by cells.

_____ 3. Neurotransmitter or hormone that can bind to a receptors and activate or inhibit enzyme activity.

_____ 4. Substance formed by a biochemical pathway that can inhibit the enzyme responsible for the first step in the pathway.

Carbohydrate Metabolism

"*Monosaccharides are the breakdown products of carbohydrate digestion.*"

A. Match these terms with the correct statement or definition:

Glucose NADH
Glycogen

_____ 1. The most important monosaccharide as far as cellular metabolism is concerned.

_____ 2. Glucose can be converted into this substance for short-term energy storage; mostly found in skeletal muscle and the liver.

_____ 3. Carrier molecule used to transport energy to the electron-transport chain.

B. Match these terms with the correct statement or definition:

Acetyl CoA
Aerobic respiration
Anaerobic respiration
Citric acid cycle
Electron-transport chain
Glycolysis
Oxygen debt

_____ 1. The breakdown of glucose to pyruvic acid; produces two ATP molecules.

_____ 2. The breakdown of glucose to lactic acid in the absence of oxygen; produces two ATP molecules.

_____ 3. The oxygen necessary to convert lactic acid to glucose.

_____ 4. The breakdown of glucose to carbon dioxide and water in the presence of oxygen; produces 38 ATP molecules.

_____ 5. Derived from pyruvic acid and enters the citric acid cycle.

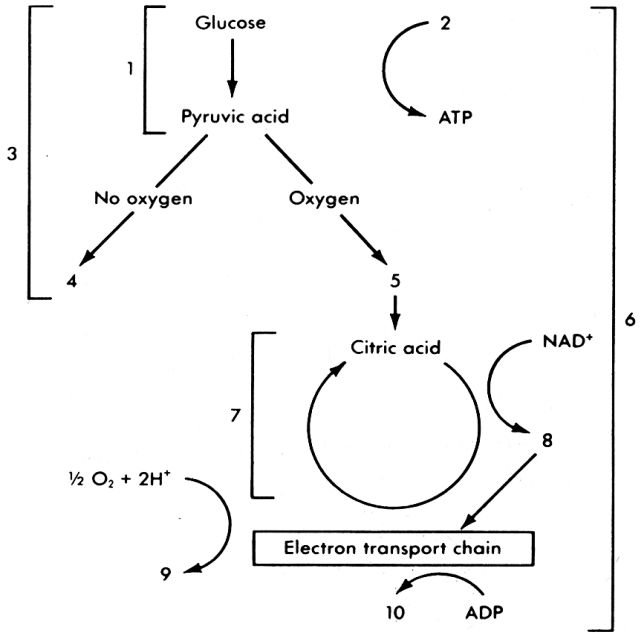
_____ 6. Releases energy from nutrient molecules that are transported to the electron-transport chain; involves the continual production of citric acid.

_____ 7. The energy in energy-transport molecules is used to produce ATP; oxygen combines with hydrogen to form water.

We must breathe oxygen to live because, without oxygen, there can be no formation of water by the electron transport chain. This effectively stops the production of most ATP.

C. Match these terms with the correct terms labeled in figure 17.1:

Acetyl CoA
ADP
ATP
Aerobic respiration
Anaerobic respiration
Citric acid cycle
Glycolysis
H_2O
Lactic acid
NADH



1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Figure 17.1

Lipid and Protein Metabolism

"*Lipids and proteins are important components of metabolism.*"

Match these terms with the correct statement or definition:

Acetyl CoA
Amino acids
Ammonia
Fatty acids
Ketone bodies
Triacylglycerol
Urea

_____ 1. The body's main energy storage molecule.

_____ 2. Released from adipose tissue when lipids are broken down; used by other tissues as an energy source.

_____ 3. Formed from the breakdown of fatty acids; can enter the citric acid cycle and be used to generate ATP.

_____ 4. Formed from acetyl CoA in the liver and released into the blood; provides energy to other tissues.

_____ 5. Used to synthesize proteins; only secondarily used for energy.

_____ 6. Produced when amino acids are broken down.

_____ 7. The liver converts ammonia into this substance, which is eliminated by the kidneys.

Metabolic States

"*There are two major metabolic states in the body.*"

Match these terms with the correct statement or definition:

Absorptive state
Postabsorptive state

_____ 1. This metabolic state occurs immediately after a meal.

_____ 2. Glucose is used for energy; excess glucose is converted into glycogen or fats.

_____ 3. Amino acids are used for protein synthesis, energy, or are converted into fats or carbohydrates.

_____ 4. Blood glucose levels are maintained by the conversion of other molecules to glucose.

_____ 5. Glycogen is converted into glucose by the liver.

_____ 6. Fatty acids are converted into acetyl CoA that enters the citric acid cycle to produce ATP.

_____ 7. Amino acids are converted into glucose.

Metabolic Rate

"*The metabolic rate is the total amount of energy produced and used by the body per unit of time.*"

Match these terms with the correct statement or definition:

Assimilation
Basal metabolic rate
Kilocaloric intake
Skeletal muscle contractions

_____ 1. Provides the energy needed to keep the resting body functional.

_____ 2. The energy needed to produce digestive enzymes and absorb digested foods.

_____ 3. Reducing this factor can result in weight loss.

_____ 4. Increasing this factor can result in weight loss.

A pound of body fat has 3500 Kilocalories.

Body Temperature Regulation

"*Humans can maintain a constant body temperature even though environmental temperatures vary.*"

Match these terms with the correct statement or definition:

Conduction
Convection
Evaporation
Free energy
Heat
Homeotherm
Hypothalamus
Radiation
Vasoconstriction
Vasodilation

_____ 1. Term that describes the ability to maintain a constant body temperature.

_____ 2. Total amount of energy that can be liberated from food.

_____ 3. Portion of free energy that is not used in anabolism, muscular contractions, or other cellular activities.

_____ 4. Transfer of heat between the body and the air.

_____ 5. Exchange of heat between objects that are in direct contact with each other, such as the bottom of the feet and the ground.

_____ 6. Loss or gain of heat from the body by infrared energy.

_____ 7. Increases heat loss by changing blood flow through the skin.

_____ 8. Part of the brain that controls the body's heat exchange mechanisms.

Increases or decreases of body temperature affect the ability of enzymes to function properly.

QUICK RECALL

1. List the six major classes of nutrients.

2. List the main functions of carbohydrates in the body.

3. List the main functions of lipids in the body.

4. Name the main functions of proteins in the body.

5. List the two phases of anaerobic respiration and state how many ATP molecules are produced in anaerobic respiration.

6. List the three phases of aerobic respiration and state how many ATP molecules are produced in aerobic respiration.

7. List the three ways metabolic energy can be used.

8. List four ways heat is exchanged between the body and the external environment.

WORD PARTS

Give an example of a new vocabulary word that contains each word part.

WORD PART	MEANING	EXAMPLE
glyco-	sweet	1. _____
lysis-	loosening	2. _____
metab-	a change	3. _____
lip-	fat	4. _____
vita-	life	5. _____
-therm	heat	6. _____

MASTERY LEARNING ACTIVITY

Place the letter corresponding to the correct answer in the space provided.

_____ 1. Complex carbohydrates
a. include sucrose.
b. can be found in large amounts in milk.
c. form an energy storage molecule in plants and animals.
d. all of the above

_____ 2. The primary energy source in the typical American diet is
a. carbohydrates.
b. fats.
c. proteins.
d. cellulose.

_____ 3. A good source of monounsaturated fats is
a. the fats of meats.
b. egg yolks.
c. whole milk.
d. fish oil.
e. olive oil.

_____ 4. A complete protein food
a. provides the daily amount (grams) of protein recommended in a healthy diet.
b. can be used to synthesize the nonessential amino acids.
c. contains all 20 amino acids.
d. includes beans, peas, and leafy green vegetables.

_____ 5. Concerning vitamins,
a. most can be synthesized by the body.
b. they are normally broken down before they can be used by the body.
c. A, D, E, and K are water-soluble vitamins.
d. they function as coenzymes.

_____ 6. Minerals are
a. inorganic nutrients.
b. compose about 4% to 5% of total body weight.
c. act as coenzymes, buffers, and regulators of osmotic pressure.
d. all of the above

_____ 7. Anaerobic respiration occurs in the _____ of oxygen and produces _____ energy for the cell than does aerobic respiration.
a. absence, less
b. absence, more
c. presence, less
d. presence, more

_____ 8. Which of the following reactions takes place in both anaerobic and aerobic respiration?
a. glycolysis
b. production of acetyl CoA
c. citric acid cycle
d. electron-transport chain

_____ 9. The production of ATP by the electron-transport chain is accompanied by the production of
a. alcohol.
b. water.
c. oxygen.
d. lactic acid.

_____ 10. The carbon dioxide you breathe out comes from
a. glycolysis.
b. the electron-transport chain.
c. anaerobic respiration.
d. the food you eat.

_____ 11. Fatty acids are
a. derived from glycogen.
b. derived from ketones.
c. broken down into acetyl CoA.
d. broken down into lactic acid.

_____ 12. Ammonia is
a. formed when amino acids are broken down.
b. toxic to cells.
c. converted into urea in the liver.
d. all of the above

_____ 13. The energy in food can be
a. used in anabolism.
b. released as heat.
c. expressed as kilocalories.
d. all of the above

_____ 14. The major use of energy by the body is for
a. basal metabolism.
b. physical activity.
c. assimilation of food.
d. thinking of answers to these questions.

_____ 15. The loss of heat caused by the loss of water from the surface of the body is called
a. radiation.
b. evaporation.
c. conduction.
d. convection.

FINAL CHALLENGES

Use a separate sheet of paper to complete this section.

1. When a person is trying to lose weight, a reduction in kilocaloric input and exercise is recommended. Give three reasons why exercise helps to reduce weight.

2. Suppose a typical male and female of the same weight went on a diet to lose weight. If they both ate the same amount and kind of food and did the same amount and kind of exercise, would they both lose weight at the same rate?

3. It is recommended that a person on a diet drink six to eight glasses of cool water per day. How could this practice help a person to lose weight?

4. In some diseases an infection results in a high fever. The patient is on the way to recovery when the crisis is over and body temperature begins to return to normal. If you were looking for symptoms in a patient who had just passed through the crisis state, would you look for a dry, pale skin or for a wet, flushed skin? Explain.