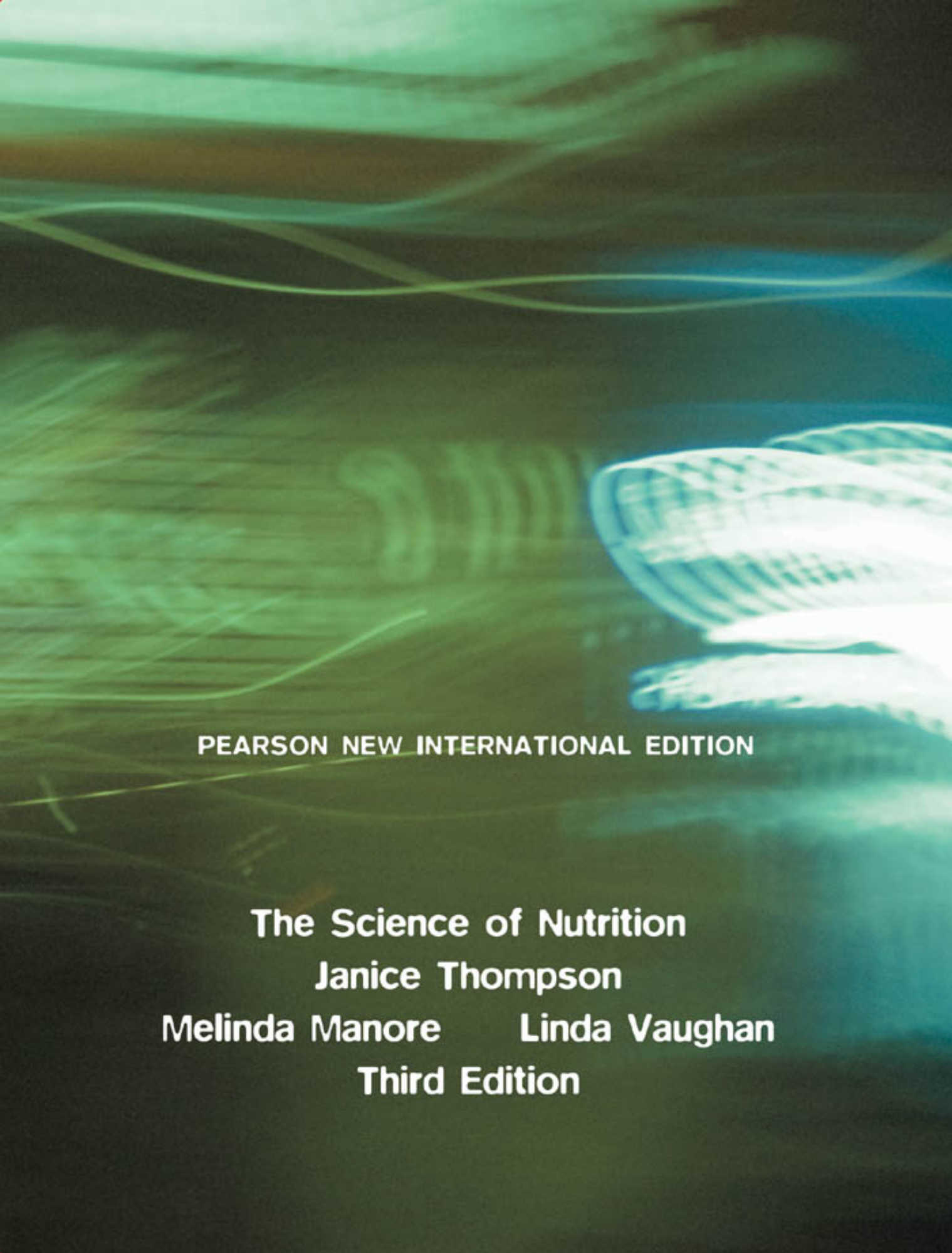

PEARSON NEW INTERNATIONAL EDITION

The Science of Nutrition

Janice Thompson
Melinda Manore Linda Vaughan

Third Edition

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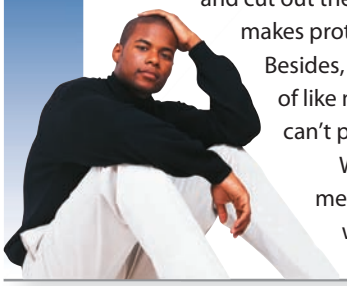
PEARSON

Nutri-Case

Theo



"No way would I ever become a vegetarian! The only way to build up your muscles is to eat meat. I was reading in a bodybuilding magazine last week about a new diet called the *Protein Path to Power* that says if you eat a diet really high in lean meats and cut out the junk foods, you'll gain muscle but not fat because 'protein makes protein, but fat and sugar make fat.' That makes sense to me. Besides, after a game I just crave meat. If I don't have it, I feel sort of like my batteries don't get recharged. Competitive athletes just can't perform without meat."

What specific claims does Theo make here about the role of meat in the diet? Do you think these claims are valid? Why or why not?

introduced much later, as the protein levels in the blood must improve to the point at which the body can use them to carry fat, so that it can be safely metabolized by the body.

Kwashiorkor Results from a Low-Protein Diet

Kwashiorkor often occurs in developing countries when infants are weaned early due to the arrival of a subsequent baby. This deficiency disease is typically seen in young children (1 to 3 years of age) who no longer drink breast milk. Instead, they often are fed a low-protein, starchy cereal. Unlike marasmus, kwashiorkor often develops quickly and causes the person to look swollen, particularly in the belly. This is because the low protein content of the blood is inadequate to keep fluids from seeping into the tissue spaces. These are other symptoms of kwashiorkor:

- Some weight loss and muscle wasting, with some retention of body fat
- Retarded growth and development but less severe than that seen with marasmus
- Edema, which results over time in extreme distension of the belly and is caused by fluid and electrolyte imbalances
- Fatty degeneration of the liver
- Loss of appetite, sadness, irritability, and apathy
- Development of sores and other skin problems; skin pigmentation changes
- Dry, brittle hair that changes color, straightens, and falls out easily

Kwashiorkor can be reversed if adequate protein and energy are given in time. Because of their severely weakened immune systems, many individuals with kwashiorkor die from infectious diseases they contract in their weakened state. Of those who are treated, many return home to the same impoverished conditions, only to develop this deficiency once again.

Many people think that only children in developing countries suffer from these diseases. However, protein–energy malnutrition occurs in all countries and affects both children and adults. In the United States, poor people living in inner cities and isolated rural areas are especially affected. Others at risk include the elderly, the homeless, people with eating disorders, those addicted to alcohol and other drugs, and individuals with wasting diseases, such as AIDS or cancer.

kwashiorkor A form of protein–energy malnutrition that is typically seen in developing countries in infants and toddlers who are weaned early. Denied breast milk, they are fed a cereal diet that provides adequate energy but inadequate protein.

Disorders Related to Genetic Abnormalities

Numerous disorders are caused by defective DNA. These genetic disorders include phenylketonuria (PKU), sickle cell anemia, and cystic fibrosis.

Phenylketonuria is an inherited disease in which a person does not have the ability to break down the amino acid phenyalanine. As a result, phenylalanine and its metabolic by-products build up in tissues and can cause brain damage. Individuals with PKU must eat a diet that is severely limited in phenylalanine.

Sickle cell anemia is an inherited disorder of the red blood cells in which a single amino acid present in hemoglobin is changed. As shown in Figure 9, normal hemoglobin is globular, giving red blood cells a round, doughnut-like shape. The genetic alteration that occurs with sickle cell anemia causes the red blood cells to be shaped like a sickle or a crescent (**Figure 18**). Because sickled red blood cells are stiff and sticky, they cannot flow smoothly through the smallest blood vessels. Instead, they block the vessels, depriving nearby tissues of their oxygen supply and eventually damaging vulnerable organs, particularly the spleen. Sickled cells also have a life span of only about 10 to 20 days, as opposed to the 120-day average for globular red blood cells. The body's greatly increased demand for new red blood cells leads to severe anemia. Other signs and symptoms of sickle cell anemia include impaired vision, headaches, convulsions, bone degeneration, and decreased function of various organs. This disease occurs in any person who inherits the sickle cell gene from both parents.

Cystic fibrosis is an inherited disease that primarily affects the respiratory system and digestive tract. It is caused by a defective gene that causes cells to build and then reject an abnormal version of a protein that normally allows the passage of chloride into and out of certain cells. This alteration in chloride transport causes cells to secrete thick, sticky mucus. The linings of the lungs and pancreas are particularly affected, causing breathing difficulties, lung infections, and digestion problems that lead to nutrient deficiencies. Symptoms include wheezing, coughing, and stunted growth. The severity of this disease varies greatly; some individuals with cystic fibrosis live relatively normal lives, whereas others are seriously debilitated and die in childhood.

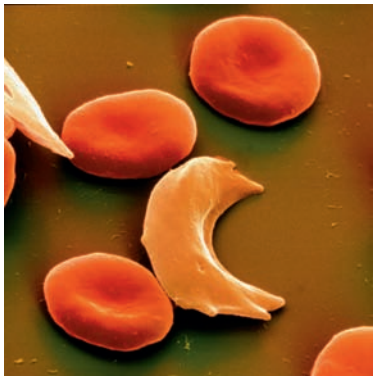


FIGURE 18 A sickled red blood cell.

sickle cell anemia A genetic disorder that causes red blood cells to be shaped like a sickle or crescent. These cells cannot travel smoothly through blood vessels, causing cell breakage and anemia.

cystic fibrosis A genetic disorder that causes an alteration in chloride transport, leading to the production of thick, sticky mucus that causes life-threatening respiratory and digestive problems.

RECAP

Protein–energy malnutrition can lead to marasmus and kwashiorkor. These diseases primarily affect impoverished children in developing nations. However, residents of developed countries are also at risk, especially the elderly, the homeless, people who abuse alcohol or other drugs, and people with AIDS, cancer, and other wasting diseases. Genetic disorders involving abnormal proteins include phenylketonuria, sickle cell anemia, and cystic fibrosis. ■

Chapter Review

TEST YOURSELF | ANSWERS

1 F Although protein can be used for energy in certain circumstances, fats and carbohydrates are the primary sources of energy for our bodies.

2 F There is no evidence that consuming amino acid supplements assists in building muscle tissue. Consuming adequate energy and exercising muscles, specifically using weight training, build muscle tissue.

3 F Excess protein is broken down and its component parts are either stored as fat or used for energy or tissue building and repair. Only the nitrogen component of protein is excreted in the urine.

4 F Vegetarian diets can meet and even exceed an individual's protein needs, assuming that adequate energy-yielding macronutrients, a variety of protein sources, and complementary protein sources are consumed.

5 T Most people in the United States consume 1.5 to 2 times more protein than they need.

Summary

- Unlike carbohydrates and fat, the structure of proteins is dictated by DNA, and proteins contain nitrogen.
- Amino acids are the building blocks of proteins; they are composed of an amine group, an acid group, a hydrogen atom, and a unique side chain.
- There are twenty different amino acids in our bodies: nine are essential amino acids, meaning that our bodies cannot produce them, and we must obtain them from food; eleven are nonessential, meaning our bodies can make them, so they do not need to be consumed in the diet.
- Our genetic makeup determines the sequence of amino acids in our proteins. *Gene expression* refers to using a gene in a cell to make a protein.
- Deoxyribonucleic acid (DNA) is the genetic template for gene expression and protein synthesis. The building blocks of DNA are nucleotides, molecules composed of a phosphate group, a pentose sugar called deoxyribose, and one of four nitrogenous bases.
- Protein turnover involves the synthesis of new proteins and the degradation of existing proteins.
- The three-dimensional shape of proteins determines their function in the body.
- When proteins are exposed to damaging substances, such as heat, acids, bases, and alcohol, they are denatured, meaning they lose their shape and function.
- A limiting amino acid is one that is missing or in limited supply, preventing the synthesis of adequate proteins.
- Mutual supplementation is the process of combining two incomplete protein sources to make a complete protein. The two foods involved in this process are called complementary proteins.
- Most of the digestion of proteins occurs in the small intestine.
- Protein quality is determined by its amino acid content and digestibility. Higher-quality proteins contain more essential amino acids and are more digestible. Animal sources, soy protein, and legumes are highly digestible forms of protein.
- Proteins are needed to promote cell growth, repair, and maintenance. They act as enzymes and hormones; help maintain the balance of fluids, electrolytes, acids, and bases; and support healthy immune function. They are also critical for nutrient transport and storage.
- The RDA for protein for sedentary adults is 0.8 g of protein per kilogram of body weight per day; protein should comprise 10% to 35% of total energy intake. Most people in the United States routinely eat much more than the RDA for protein.

- High protein intakes are claimed to be harmful. Recent evidence suggests that high-protein diets do not lead to increased blood cholesterol levels if protein sources low in saturated fat are consumed, and bone health should not be compromised with high protein intakes if adequate calcium is consumed. High-protein diets can increase the risk for kidney disease in susceptible people.
- There are many forms of vegetarianism: lacto-ovo-vegetarians eat plant foods plus eggs and dairy products; pescovegetarians consume plant foods and rely on fish as the only meat source; vegans consume only plant foods.
- Consuming a well-planned vegetarian diet may reduce the risk for obesity, heart disease, type 2 diabetes, and some forms of cancer.
- Vegans may need to supplement their diet with vitamins B_{12} and D, riboflavin, iron, calcium, and zinc.
- Marasmus and kwashiorkor are two forms of protein–energy malnutrition that results from grossly inadequate energy and protein intake.
- Phenylketonuria is a genetic disease in which the person cannot break down the amino acid phenylalanine. The buildup of phenylalanine and its by-products leads to brain damage.
- Sickle cell anemia is a genetic disorder of the red blood cells. Because of an alteration of one amino acid in hemoglobin, the red blood cells become sickle-shaped and cannot travel smoothly through blood vessels. This blocks the vessels, causing inadequate oxygenation of nearby tissues, organ damage, and anemia.
- Cystic fibrosis is a genetic disease that causes an alteration in chloride transport, leading to the production of thick, sticky mucus. This mucus causes serious respiratory and digestive problems, which lead to variable levels of debilitation and, in some cases, premature death.

MasteringNutrition™

To further your understanding, go online and apply what you've learned to real-life case studies that will help you master the content!

Review Questions

1. The process of combining peanut butter and whole-wheat bread to make a complete protein is called
   a. deamination.
   b. vegetarianism.
   c. transamination.
   d. mutual supplementation.
2. Which of the following meals would be appropriate in a well-planned vegan diet?
   a. rice, pinto beans, acorn squash, soy butter, and almond milk
   b. veggie dog, bun, and a banana–yogurt milkshake
   c. brown rice and green tea
   d. egg salad on whole-wheat toast, broccoli, carrot sticks, and soy milk
3. The substance that breaks down polypeptides in the small intestine is called
   a. hydrochloric acid.
   b. pepsin.
   c. protease.
   d. ketones.
4. The portion of an amino acid that contains nitrogen is called the
   a. R group.
   b. amine group.
   c. acid group.
   d. nitrate cluster.
5. All proteins contain
   a. carbon, oxygen, iron, and nitrogen.
   b. iron, oxygen, and hydrogen.
   c. carbon, hydrogen, oxygen, and nitrogen.
   d. carbon, hydrogen, oxygen, and sulfur.
6. **True or false?** After leaving the small intestine, amino acids are transported to the liver for distribution throughout the body.
7. **True or false?** When a protein is denatured, its shape is lost but its function is retained.
8. **True or false?** All hormones are proteins.
9. **True or false?** Buffers help the body maintain acid–base balance.
10. **True or false?** Athletes typically require about three times as much protein as nonactive people.
11. Explain the relationship between inadequate protein intake and the swollen bellies of children with kwashiorkor.
12. Explain the relationship between excessive protein intake and an increased risk for kidney disease.
13. Differentiate between the roles of mRNA and tRNA in DNA replication.

14. You've always thought of your dad as a bit of a "health nut," so you're not surprised when you come home on spring break and he offers you a dinner of stir-fried vegetables and something called *quorn.* Over dinner, he announces that he has joined an online vegetarian chat group. "But, Dad," you protest, "you still eat meat, don't you?" "Sure I do," he answers, "but only once or twice a week. Lots of the other people in my chat group occasionally eat meat, too!" In your opinion, is vegetarianism an identity, a lifestyle choice, or a fad? Defend your position.

15. Draw a sketch showing how amino acids bond to form proteins.

Math Review

16. Barry is concerned he is not eating enough protein. After reading this chapter, he recorded his diet each day for 1 week to calculate how much protein he is eating. Barry's average protein intake for the week is equal to 190 g, and his daily energy intake averages 3,000 kcal. Barry weighs 182 lb. Based on your calculations, is Barry (a) meeting or exceeding the AMDR for protein and (b) meeting or exceeding the RDA for protein?

Answers to Review Questions and Math Review can be found online in the MasteringNutrition Study Area.

Web Links

www.eatright.org
Academy of Nutrition and Dietetics
Search for "vegetarian diets" to learn how to plan healthful meat-free meals.

www.fnic.nal.usda.gov
USDA Food and Nutrition Information Center
Click on "food consumption" in the left navigation bar to find a searchable database of the nutrient values of foods.

www.cdc.gov
Centers for Disease Control and Prevention
Click on "Health Topics A-Z" to learn more about E. coli and mad cow disease.

www.who.int/nutrition/en/
World Health Organization Nutrition Site
Visit this site to learn more about the worldwide scope of protein-deficiency diseases and related topics.

www.nlm.nih.gov/medlineplus
MEDLINE Plus Health Information
Search for "sickle cell anemia" and "cystic fibrosis" to obtain additional information and resources, and the latest developments for these diseases.

www.vrg.org
Vegetarian Resource Group
Visit this site for additional information on how to build a balanced vegetarian diet.

www.choosemyplate.gov/healthy-eating-tips/tips-for-vegetarian.html
MyPlate.gov
This section of the MyPlate website contains useful, healthy eating tips for vegetarians.

www.meatlessmonday.com
Meatless Monday Campaign
Find out how to start going meatless one day a week with this innovative campaign's website.

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