

# Human Nutrition

SCIENCE FOR HEALTHY LIVING

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# Human Nutrition

Science for Healthy Living

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## HUMAN NUTRITION: SCIENCE FOR HEALTHY LIVING

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# About the Authors



**Tammy J. Stephenson, PhD,** received her BS in Food Science and Human Nutrition and PhD in Nutritional Sciences from the University of Kentucky. She has taught a wide variety of food, nutrition, and wellness

courses, including introductory nutrition, to majors and nonmajors in the Department of Dietetics and Human Nutrition at the University of Kentucky for the past 15 years. Dr. Stephenson is an active member of the Academy of Nutrition and Dietetics, serving as Chair of the Nutrition Educators of Health Professionals practice group. She has published and presented on service learning, technology in teaching, student-centered learning, and other related topics. Dr. Stephenson has a passion for teaching engaging, interesting, and relevant nutrition courses that has been recognized through multiple teaching and mentoring awards at the university, state, and national levels. Outside of the classroom, she enjoys running, yoga, coaching youth soccer, gardening, cooking, and spending time with her family.

*To Brian, Bailey, Kylie Mae,  
and Ansley*

—Tammy Stephenson



**Wendy J. Schiff, MS, RDN,** received her BS in Biological Health/Medical Dietetics and MS in Human Nutrition from The Pennsylvania State University. She has taught introductory food and nutrition courses at the University of

Missouri–Columbia as well as nutrition, biology, and personal health courses at St. Louis Community College–Meramec. She has worked as a public health nutritionist at the Allegheny County Health Department (Pittsburgh, Pennsylvania) and State Food and Nutrition Specialist for Missouri Extension at Lincoln University in Jefferson City, Missouri. In addition to coauthoring *Human Nutrition: Science for Healthy Living*, Wendy has authored *Nutrition for Healthy Living* and *Nutrition Essentials: A Personal Approach*.

*To Bill and Kevin*

—Wendy Schiff

# Welcome to the First Edition of *Human Nutrition: Science for Healthy Living*

Dear Students,

Welcome to the study of human nutrition! Before you begin your studies, it is important to understand that nutrition is a science that draws upon knowledge from other sciences, particularly biology, human anatomy and physiology, general chemistry, and biological chemistry. The science of human nutrition also involves learning scientific information about foods and nutrition, and how this information is used to develop dietary recommendations for healthy people and nutritional therapies for those who are not healthy. By understanding the contents of this introductory nutrition textbook, you will recognize the effects that peoples' food choices can have on their health. In addition, you will appreciate the valuable role that registered dietitian nutritionists (RDNs) play as members of the health care team and be well prepared to take more advanced human nutrition courses, if you decide to become a dietitian.

*Human Nutrition: Science for Healthy Living* has been developed by a team of nutrition educators who have extensive college teaching experience and a passion for teaching relevant, student-centered nutrition, foods, health, and wellness courses. Our overall goal is to prepare you for your career in a health care discipline, and we want you to enjoy your introductory study of human nutrition. Learning about any science can be challenging if the information is not presented in an appealing, interesting manner. We've made a distinct effort to write the content of this book in an understandable way and to provide clear descriptions of concepts that can be difficult to convey, such as the processes of digestion, absorption, and energy metabolism. To enhance your learning, numerous meaningful illustrations and photographs accompany the narrative. Such graphics facilitate learning for all students, but especially for those who are "visual learners." By reviewing pages xv–xxiv of this Preface, you will learn about the features of this book and how to use them to facilitate your study of human nutrition.

We hope you will enjoy using this textbook!

*Tammy J. Stephenson*

*Standy J. Schiff*



# Preface

Wendy Schiff, author of *Nutrition for Healthy Living* and *Nutrition Essentials: A Personal Approach*, and Tammy Stephenson are a “dream team” to collaborate on this exciting new majors nutrition project. Wendy’s years of teaching nutrition and other science courses, proven pedagogical expertise, and engaging writing style combined with Tammy’s passion for and experience teaching both traditional face-to-face courses and online nonmajors- and majors-level nutrition courses make them the perfect pair to produce accessible majors-level content for today’s students.

Tammy and Wendy had a vision of writing an interesting, engaging, and evidence-based introductory nutrition textbook that has a wide variety of pedagogical features to promote active learning. To that end, *Human Nutrition: Science for Healthy Living* is learner-centered, easy to read, and richly illustrated with figures that clearly show physiological processes. Furthermore, the author team felt students and faculty would appreciate a textbook that was clinically oriented and provided ample opportunities for students to practice using their nutrition knowledge and critical thinking skills. *Human Nutrition: Science for Healthy Living* is the result of Tammy and Wendy’s efforts.

The clinical emphasis of the textbook is of particular relevance to those studying nutrition, dietetics, or other health science professions, including nursing. Specific real-life examples, current statistics, and scientific evidence from professional resources are provided to support nutrition concepts. Features designed to attract students’ interest, such as *Did You Know?* and *Fresh Tips* boxes, provide up-to-date information on current and sometimes controversial topics, as well as practical recommendations for everyday healthy living.

Instructors often assert that their students do not use the textbook. One of the authors’ primary goals in developing *Human Nutrition: Science for Healthy Living* was to create a text with an easy-to-understand writing style and appealing layout that would engage students, so they will actually *want* to open the textbook, read the material, and study it.

*Human Nutrition: Science for Healthy Living* provides the framework for students to *learn* how nutrition information is often interrelated and to *apply* the science of nutrition to clinical situations. Furthermore, students can use their foods and nutrition knowledge throughout their lives.

## Features Designed Around Student-Centered Learning

*Human Nutrition: Science for Healthy Living* was written by authors who have extensive experience teaching introductory nutrition classes to both majors and nonmajors. The authors recognize the diverse learning needs of today’s students and how the modern learning environment in higher education—large lecture classes, online classes, and flipped/hybrid classrooms—often challenge even the most experienced nutrition educators. The textbook and its supportive interactive materials are designed to help instructors create a learner-centered teaching environment that maximizes student engagement and knowledge acquisition. This current, evidence-based introductory textbook has a wide variety of pedagogical features to promote active learning among students.

**Case Study**—Each chapter begins with a case study addressing a realistic scenario. These high-interest scenarios engage the student by showing how the chapter's content is relevant to their future professions and can be utilized in a practical or clinical situation. Students are encouraged to consider the case study as they study the chapter. A suggested **Case Study Response** is provided at the end of the chapter to allow students to self-assess their understanding of the material and its applications.

## 5 Carbohydrates: Sugars, Starches, and Fiber

### CASE STUDY

#### Carbohydrates for breakfast?

JERRY IS A GRADUATE STUDENT WORKING on his doctorate. Two months ago, Jerry read an article posted on an Internet website about the importance of limiting intakes of carbohydrates, particularly at breakfast. Since reading the article, Jerry has consumed only a fried egg, three pieces of bacon, and a glass of water for breakfast. He also avoids eating carbohydrate-containing foods at other meals. Although Jerry does not need to lose weight, he does have a family history of type 2 diabetes and heart disease.

- Describe to Jerry the different categories of carbohydrates and how each of these classes may influence his health.
- Provide Jerry with two examples of breakfasts that incorporate healthy, nutrient-dense carbohydrates.
- Explain to Jerry why eating carbohydrates does not necessarily cause diabetes.

The suggested Case Study Response can be found on page 142.

 Check out the Connect site at [www.mcgrawhillconnect.com](http://www.mcgrawhillconnect.com) to further explore this case study.

### QUIZ Yourself

Would sweetening cereal with honey be a healthier choice than using table sugar? Is fiber good for one's health? Check your knowledge of carbohydrates by taking the following quiz. The answers are found on page 146.

1. The carbohydrate found in milk is called lactose.  T  F
2. Ounce per ounce, sugar provides more energy than starch.  T  F
3. Digestion of starch begins in the mouth.  T  F
4. Eating a high-fiber diet can improve the functioning of the large intestine and reduce blood cholesterol levels.  T  F
5. Individuals with diabetes should follow a carbohydrate-free diet.  T  F

### CASE STUDY RESPONSE

#### CARBOHYDRATES FOR BREAKFAST?



MANY AMERICANS CONSUME EXCESSIVE AMOUNTS of sucrose. Eating sugary foods can cause one's blood glucose concentration to rise rapidly and then drop quickly. By replacing simple sugars with oligosaccharides and polysaccharides, a person may reduce his or her risk of developing serious chronic diseases, particularly obesity and type 2 diabetes.

Jerry should focus on eating foods that are rich sources of complex carbohydrates, particularly dietary fiber. Nutrient-dense, carbohydrate-rich breakfast options include:

- Low-fat yogurt mixed with fresh berries, granola, and nuts
- "Quick-cooking" oatmeal mixed with berries, raisins, and nuts
- Whole-grain, ready-to-eat cereal with fresh fruit and low-fat milk
- Whole-grain waffles or pancakes sprinkled with wheat germ and topped with fresh fruit

Results of scientific studies indicate that carbohydrates as a nutrient category are not a direct cause of diabetes. Consuming too much of any digestible macronutrient and excessive weight gain can contribute to one's risk of developing type 2 diabetes.



**Quiz Yourself**—This pretest, which is next to the Case Study, stimulates interest in reading the chapter. By taking the quiz, students may be surprised to learn how little or how much they know about the chapter's contents.

**Learning Outcomes**—Each major section of a chapter opens with a list of learning outcomes. The Learning Outcomes help students prepare for reading the section and also clarify major concepts they are expected to learn. These measurable outcomes are further supported by assessment methods and study aids found within the chapters and within McGraw-Hill Education's Connect®.

## 3.5 Food Guides for Dietary Planning

### LEARNING OUTCOMES

- 1 Explain how to use MyPlate to develop nutritionally adequate daily menus for healthy adults and children.
- 2 Describe educational resources available at [www.choosemyplate.gov](http://www.choosemyplate.gov).
- 3 Identify tools people with diabetes can use for diet planning.



**Assess Your Progress**—These review questions, which appear at the end of each major section within a chapter, apply to the section’s learning outcomes and often involve critical thinking skills. Such questions enable students to test their knowledge and understanding of information provided within that section.

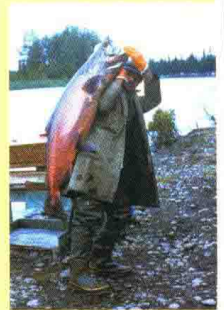
## ASSESS YOUR PROGRESS

- 17 List four recommendations for healthy eating according to MyPlate.
- 18 Explain how to use [www.choosemyplate.gov](http://www.choosemyplate.gov) to find the food groups and calories present in a mixed dish, such as one 8-oz chicken pot pie.
- 19 Define empty-calorie foods and provide two examples based on MyPlate guidelines.
- 20 Describe how the Exchange System differs from MyPlate.

**Fresh Tips**—These practical suggestions help students apply the chapter’s content to their current situations. The *Fresh Tips* are also valuable for future health care professionals who want to provide useful health, food, and nutrition advice to their clients. Such features include tips for including more seafood in diets, maintaining a healthy body weight, preventing choking in children, and keeping foods safe to eat.

## FRESH TIPS

- Eat seafood, especially fatty cold-water fish, two times a week. Before cooking, marinate fresh fish in olive or canola oil that has been seasoned with a small amount of garlic, pepper, and lemon juice. The light coating of oil on fish can help keep the fish from drying out during cooking.
- Bake, grill, or broil fish.
- Add drained, water-packed tuna to salads, or mix the tuna with a little olive oil and pickle relish, and spread on whole-wheat toast.
- When olive oil is not desired, use canola oil, soybean oil, or soft margarines made from these oils for frying or sautéing.
- Sprinkle chopped walnuts on salads, yogurt, or cereal, or eat the nuts as a snack.



A fisherman in Kenai, Alaska, carrying a freshly caught king salmon. Alaskans consume significantly more omega-3 fatty acids than the general U.S. population.

## DID YOU KNOW?

Medical researchers have limited animal models to use for studying the disease *diabetes mellitus* (“diabetes”). Scientists at the National Marine Mammal Foundation in San Diego are investigating the bottlenose dolphin as an animal model for diabetes research. These dolphins can develop diabetes. Rather than conduct research on dolphins in a laboratory setting, researchers perform tests on the animals’ blood and urine samples to determine possible links with the human form of the disease.<sup>3</sup> Chapter 5 provides more information about diabetes.



**Did You Know?**—This feature presents bits of information concerning topics that support the chapter’s content and are of interest to introductory nutrition students. Some of these features dispel beliefs about food and nutrition that are commonly held but inaccurate, such as “stick” margarine being more fattening than butter. Other “Did You Know” features report results of current and unusual areas of research, such as how certain dolphins are used to study diabetes in humans.

**Real People, Real Stories**—This unique feature provides information about real people, many of whom are college students who have recovered from or are currently living with nutrition-related conditions. Such conditions include PKU, celiac disease, type 1 diabetes, eating disorders, smell disorders, and hypertension. This feature is designed to help students recognize the daily challenges faced by people with such conditions and the roles that diet and physical activity play in managing one’s health.

## REAL People, REAL Stories

### Dallas Clasen

Dallas Clasen is majoring in engineering at the University of Wisconsin-Platteville. In addition to keeping up with his coursework, he runs cross country at school and participates in triathlons. Like most college students, Dallas is very busy, but unlike most students, he has to pay very close attention to his diet. Dallas was born with a rare inherited metabolic disorder called phenylketonuria (PKU).

A few days after birth, Dallas underwent standard newborn blood testing. The results of the test indicated that the level of phenylalanine in his blood was about 40 times higher than the normal amount, a sign of PKU. To avoid developing severe brain damage and





**Test Kitchen: Modifying Recipes for Healthy Living**—This unique feature provides students with the opportunity to apply nutrition and food information to situations that commonly arise in clinical settings. Students modify an existing recipe to make it healthier, using information they have learned in each chapter. This feature allows students to experiment with recipe modifications, such as substituting “healthy” fats for “unhealthy” ones and using less sugar and salt in recipes.

## TEST KITCHEN

### Modifying Recipes for Healthy Living

For this activity, compare the ingredients in a serving of a commercial energy drink to a serving of a smoothie that you can make at home. Then, answer the following questions.



Commercial Energy Drink			High-Caliber Smoothie†		
Ingredients		kcal	Ingredients		kcal
Water	12 oz	0	Nonfat milk	1 cup (8 oz)	80
Sucrose	1 Tbsp	120	Nonfat plain yogurt	¼ cup	35
Glucose	1 tsp	40	Frozen raspberries, unsweetened	¼ cup	30
Caffeine	100 mg		Frozen blueberries, unsweetened	¼ cup	20
B vitamins*			Banana	1 medium	100
Niacin	20 mg				
B-6	1.5 mg				
B-12	2.5 µg				
Pantothenic acid	10 mg				
<b>Total kcal:</b>		<b>160</b>	<b>Total kcal:</b>		<b>265</b>

\*All amounts at least 100% of RDA

†To make the smoothie, combine all ingredients and blend until smooth.

1. What are the sources of energy in the two drinks?
2. Not long after the drinks are consumed, blood sugar levels begin to rise, which stimulates the pancreas to release insulin. Assume the person consuming the commercial energy drink does not need the calories from the beverage for energy. In this situation, what effect would the insulin have on the body?
3. Which drink is a healthier source of energy? Explain your choice of drinks.

## PERSONAL Dietary Analysis

1. Refer to your 3-day food log from the “Personal Dietary Analysis” feature in Chapter 5.
  - a. Find the RDA/AI values for minerals under your life stage/sex group category in the DRI tables (see the inside back cover of this book). Write those values under the “My RDA/ AI” column in the table below.
  - b. Review your personal dietary assessment. Find your 3-day average intakes of iron, iodine, zinc, selenium, fluoride, and chromium. Write those values under the “My Average Intake” column of the table.
  - c. Calculate the percentage of the RDA/AI you consumed for each mineral by dividing your intake by the RDA/AI amount and multiplying the figure you obtain by 100. For example, if your average intake of iron was 9 mg/day and your RDA for the mineral is 18 mg, you would divide 9 mg by 18 mg to obtain .50. To multiply this figure by 100, simply move the decimal point two places to the right, and replace the decimal point with a percentage sign (50%). Thus, your average daily intake of iron was 50% of the RDA. Place the percentages for each mineral under the “% of My RDA/AI” column.
  - d. Under the “>, <, or =” column, indicate whether your average daily intake was greater than (>), less than (<), or equal to (=) the RDA/AI.
2. Use the information you calculated in the first part of this activity to answer the following questions:
  - a. Which of your average trace mineral intakes equaled or exceeded the RDA/AI? If one or more were above the RDA, what is a possible consequence of the overconsumption?
  - b. Which of your average trace mineral intakes was below the RDA/AI?
  - c. What foods would you eat to increase your intake of the minerals that was less than the RDA/AI levels? (Review sources of the minerals in this chapter.)



Complete the Personal Dietary Analysis activity online at [www.mcgrawhillconnect.com](http://www.mcgrawhillconnect.com), where you will also find McGraw-Hill LearnSmart®, SmartBook®, NutritionCalc Plus, and many other dynamic learning tools.

**Personal Dietary Analysis**—Students can gain insight into their eating habits by completing this activity. Many of these activities can be completed with the use of a dietary analysis software program, such as McGraw–Hill’s NutritionCalc Plus.

### Personal Dietary Analysis: Trace Minerals

Mineral	My RDA/AI	My Average Intake	% of My RDA/AI	>, <, or =
Iron				
Iodine				
Zinc				
Selenium				
Fluoride				
Chromium				



**End of Chapter**—Each chapter ends with:

- a bulleted chapter Summary;
- Critical Thinking questions that involve higher-level cognition skills, including applying, analyzing, synthesizing, and evaluating information;
- a series of multiple-choice Practice Test questions that assess students' comprehension and recall of information presented in the chapter; and
- References.

## SUMMARY

### SECTION 12.1 What Is a Trace Mineral?

- Trace minerals are essential nutrients required in very small amounts, generally less than 100 mg/day. Trace minerals include iron, iodine, zinc, selenium, fluoride, chromium, copper, manganese, molybdenum and possibly, some other minerals.

### SECTION 12.2 Iron

- Iron plays a critical role in oxygen delivery for energy metabolism as part of hemoglobin and myoglobin.
- Dietary iron can be found in two forms, heme and nonheme. The intestinal tract absorbs more of the heme iron than nonheme iron in foods. Naturally occurring components of plant foods, such as phytates and polyphenols, reduce iron absorption.
- Serum ferritin concentrations are the most common method of assessing iron status. Total body iron can be measured by calculating the ratio of blood transferrin receptor to ferritin.
- Iron deficiency occurs in three stages. Iron deficiency anemia has widespread negative effects on the body. Excess iron in the blood acts as an oxidant and causes damage to cell membranes, proteins, and DNA. Iron overload occurs when toxic amounts of iron supplements are ingested, but the condition also results from certain genetic conditions.

### SECTION 12.3 Iodine (Iodide)

- Adequate iodine is essential to form thyroid hormone. Major dietary sources of iodine include saltwater fish, seafood, seaweed, and iodized salt.
- Most Americans have adequate iodine intakes. Needs for iodine increase for pregnant and lactating women. Both deficiency and toxicity in iodine causes goiter and hypothyroidism. Infants of iodine-deficient women are likely to be born with cretinism.

### SECTION 12.4

## Critical Thinking

- Zinc is important for healing, the se

1. Identify at least six factors that influence your food and beverage selections. Which of these factors is the most important? Explain why.
2. Analyze your current eating habits. Based on your analysis, is your diet nutritionally adequate? Explain why your diet is or is not nutritionally adequate.
3. "Everything in moderation." Explain what this statement means in terms of your diet.
4. Consider your parents' and grandparents' health (or causes of death). Based on your family history, which chronic health

conditions do you have a higher than average risk of developing? If you were at risk of developing a chronic health condition that could be prevented by changing your diet, would you make the necessary changes at this stage of your life? Explain why or why not.

5. Eric spends about \$100 each month on purchases of dietary supplements, including protein powders, vitamin pills, and herbal extracts. He thinks it is necessary to take the products to achieve optimal health and prevent chronic illnesses. Based on the information in this chapter, what would you tell Eric about his use of the supplements?

## Practice Test

Select the best answer.

1. Diet is a
  - a. practice of restricting energy intake.
  - b. usual pattern of food choices.
  - c. method of reducing portion sizes.
  - d. technique to reduce carbohydrate intake.
8. Which of the following conditions is a chronic disease?
  - a. heart disease
  - b. common cold
  - c. scurvy
  - d. influenza
9. In the United States, the primary cause of preventable cancer deaths is
  - a. physical inactivity.
  - b. high-fat diet.

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Numerous high-quality photos support the text and provide examples of nutrition-related medical conditions as well as microscopic views of clinical cases from the human body.

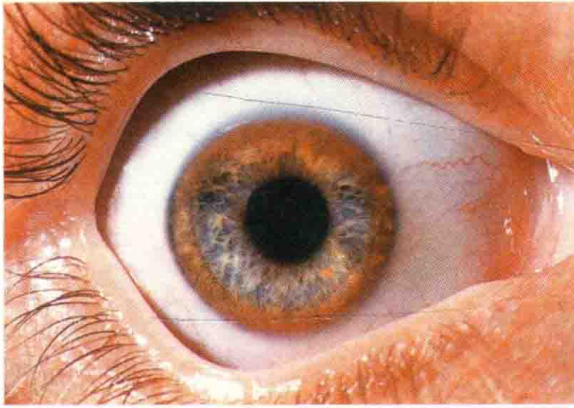


FIGURE 12.11 Kayser-Fleischer ring.

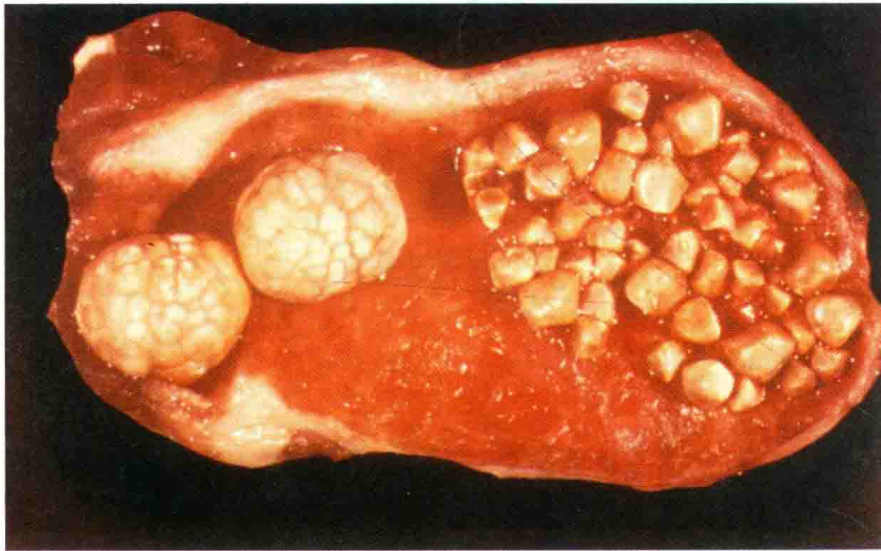


FIGURE 6.16 Gallstones. Gallstones can form in the gallbladder. The stones usually consist of cholesterol.



In developing countries, poor sanitation practices and lack of clean cooking and drinking water contribute to the spread of diseases.

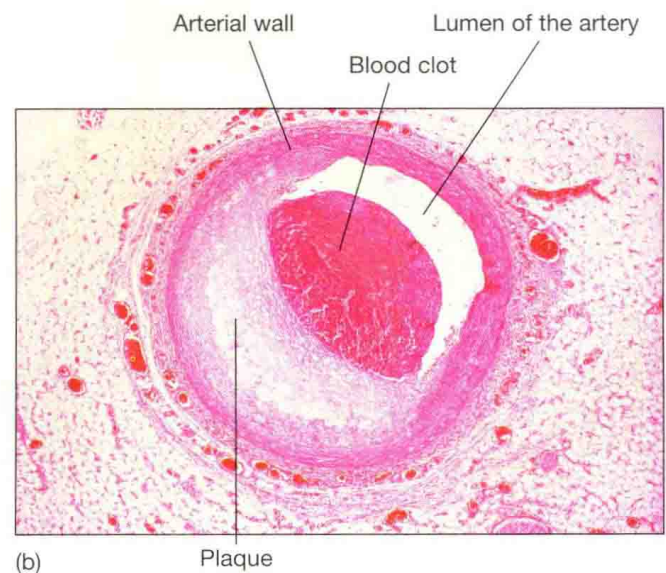
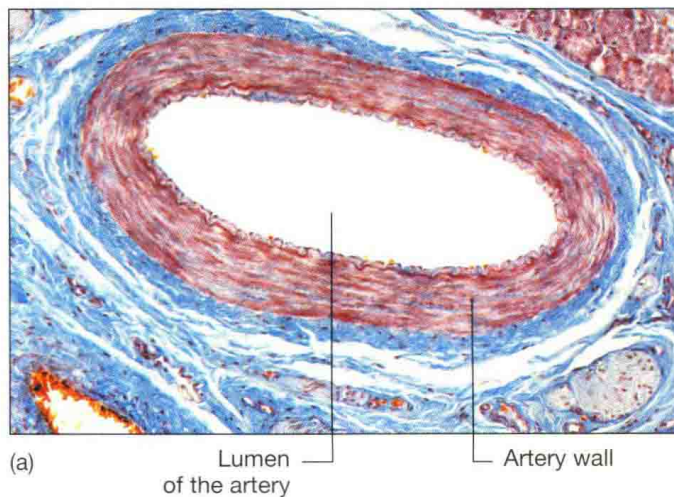


FIGURE 6.18 Healthy and atherosclerotic arteries. Note the differences between the cross section of a healthy artery (a) and that of an artery nearly completely blocked by atherosclerosis (b).



# Personalized Teaching and Learning Environment

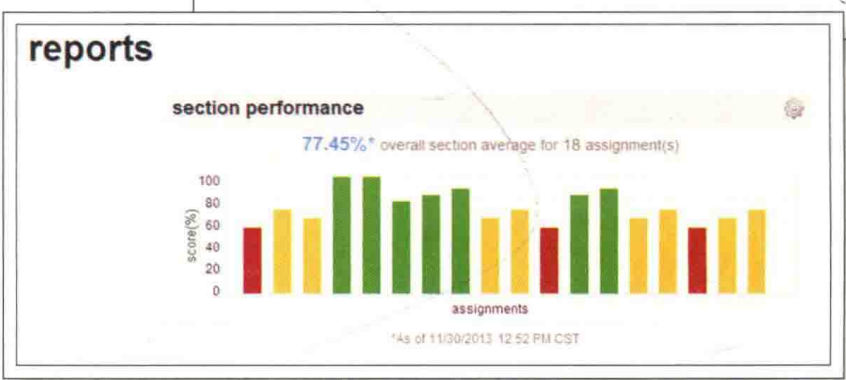
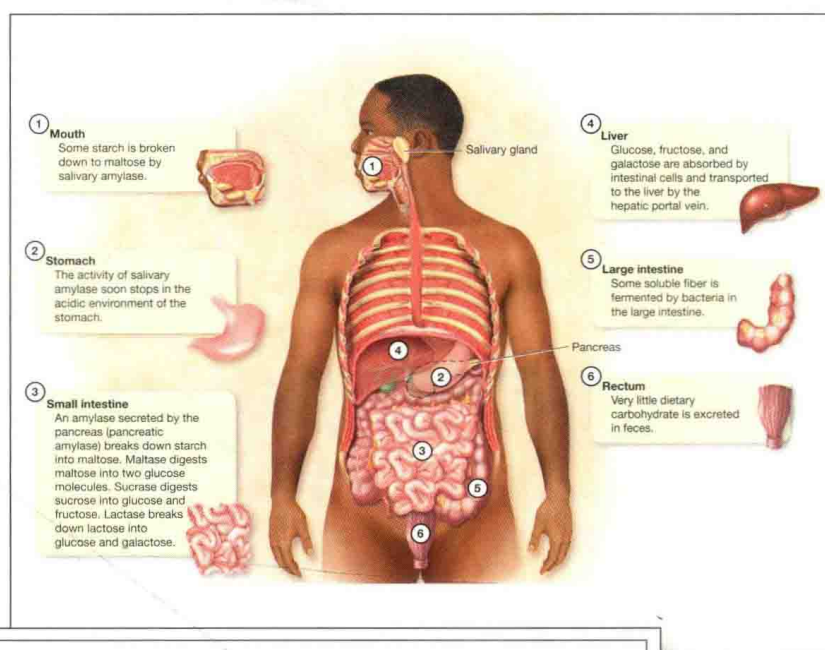


# connect<sup>®</sup>

## NUTRITION

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Digital efficacy study final analysis shows students experience higher success rates when they are required to use LearnSmart.

- Passing rates increased by an average of 11.5% across the schools and by a weighted average of 7% across all students.
- Retention rates increased an average of 10% across the schools and by a weighted average of 8% across all students.

Study details:

- The study included two state universities and four community colleges.

- Control sections assigned chapter assignments consisting of test bank questions, and the experimental sections assigned LearnSmart; both were assigned through Connect.
- Both types of assignments were counted as a portion of the grade, and all other course materials and assessments were consistent.
- 358 students opted into the LearnSmart sections and 332 students opted into the sections where test bank questions were assigned.

**Transform the way students read. SmartBook®** is the first and only adaptive reading experience available for the higher education market. Powered by LearnSmart, SmartBook facilitates the reading process by identifying what content a student knows and doesn't know through adaptive assessments. As the student reads, the reading material constantly adapts to ensure the student is focused on the content needed the most to close any knowledge gaps.

The screenshot displays the SmartBook interface for a chapter on Proteins. On the left, a ranking exercise titled "Rank the basic steps of protein synthesis" is shown. The steps are listed in a column, and users are instructed to drag them into the correct order. The steps are:
 

- RNA molecule conveys a particular amino acid to the ribosome
- The ribosomes "read" the messenger RNA
- At the ribosome, the amino acid attaches to the peptide chain
- mRNA transfers the information from the nucleus to ribosomes
- DNA unwinds exposing a gene.
- The gene undergoes transcription, forming messenger RNA

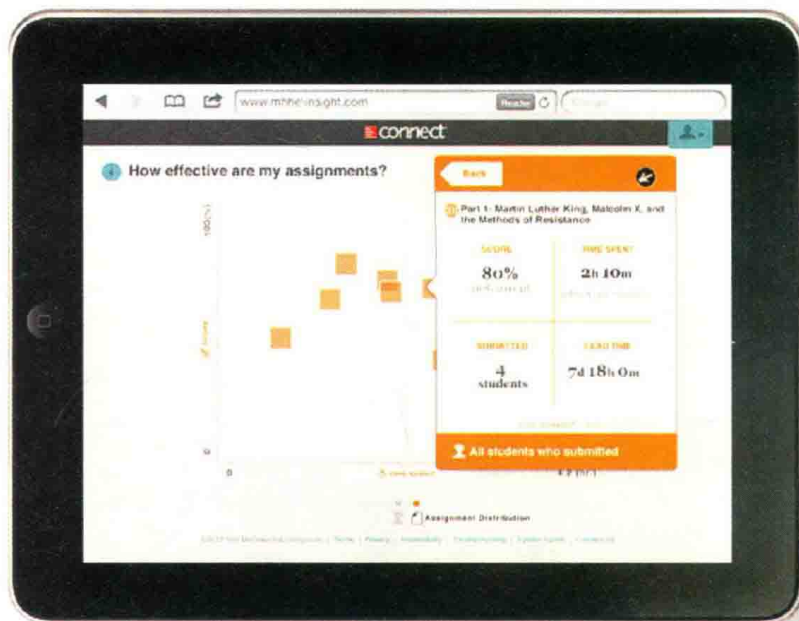
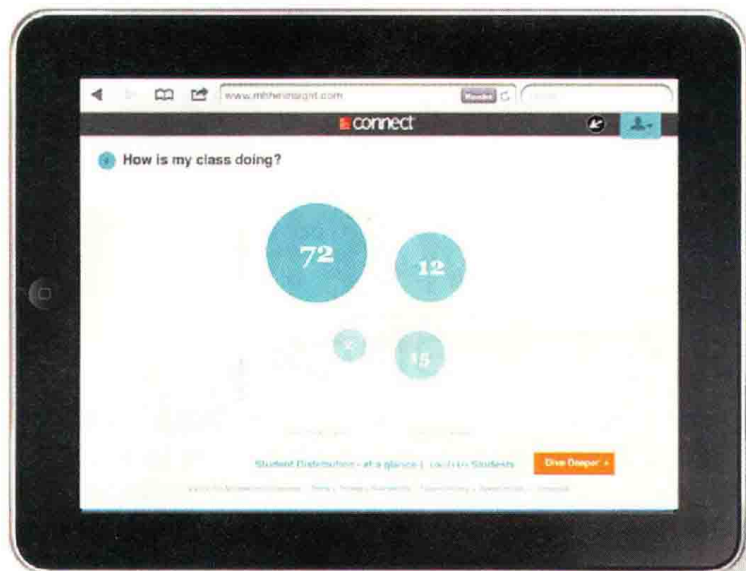
 Below the list are "Submit" and "GIVE UP!" buttons. On the right, a detailed diagram of protein synthesis is visible, showing the nucleus with DNA being transcribed into mRNA, which then moves to the cytoplasm where it is translated by ribosomes. Labels include "Cell Nucleus", "Cytoplasm", "DNA", "mRNA", "Ribosome", and "Polypeptide Chain". A "back to Connect" button is in the top right corner.





# connect<sup>INSIGHT</sup>

**Connect<sup>®</sup> Insight** is a powerful data analytics tool that allows instructors to leverage aggregated information about their courses and students to provide a more personalized teaching and learning experience.



# tegrity<sup>®</sup>

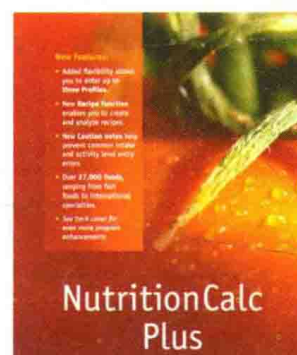
**Deliver your lecture online quickly and easily. Tegrity<sup>®</sup> Campus** is a fully automated lecture capture solution used in traditional, hybrid, "flipped classes" and online courses to record lessons, lectures, and skills.



# Campus

**MH Campus<sup>®</sup>** integrates all of your digital products from McGraw–Hill Education with your school LMS for quick and easy access to best–in–class content and learning tools.

**Inspire behavior change. NutritionCalc Plus** is an online suite of powerful dietary self–assessment tools that help students track their food intake and activity and analyze their diet and health goals. Students and instructors can trust the reliability of the ESHA database while interacting with a robust selection of reports.



# create<sup>™</sup>

**McGraw–Hill Create<sup>™</sup>** is a self–service website that allows you to create customized course materials using McGraw–Hill Education’s comprehensive, cross–disciplinary content and digital products.



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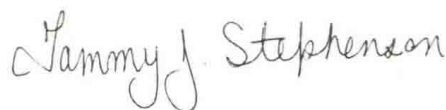
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