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AUSTRALIAN &
NEW ZEALAND EDITION

UNDERSTANDING NUTRITION

ELEANOR **WHITNEY**

SHARON RADY **ROLFES**

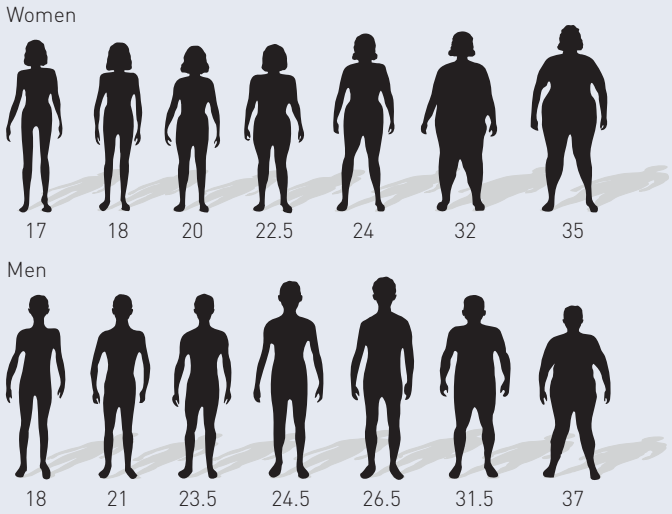
TIM **CROWE**

DAVID **CAMERON-SMITH**

ADAM **WALSH**

BODY MASS INDEX

In the table, find your height in the left-hand column and look across the row until you find the number that is closest to your weight. The number at the top of that column identifies your body mass index (BMI) (in kg/m^2). To calculate BMI yourself, divide your weight in kilograms by the square of your height in metres. Chapter 8 describes how BMI correlates with disease risks and defines obesity and Chapter 16 presents BMI for children and adolescents. The area shaded in blue represents healthy weight ranges. The figure below presents silhouettes of various BMI.



The Body Test (1988). Copyright © 1988 Dietitians of Canada. Reprinted with permission.

BODY MASS INDEX (BMI) IN kg/m^2																							
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Height (cm)	**Body weight (kg)**																						
150.0	40	43	45	47	49	52	54	56	58	60	63	65	67	69	72	74	76	78	81	83	85	88	90
152.5	42	44	46	49	51	54	56	58	60	63	65	67	69	72	74	76	79	81	83	86	88	90	93
155.0	43	45	48	50	53	55	58	60	62	65	67	69	72	74	77	79	82	84	86	88	91	93	96
157.5	44	47	49	52	54	57	59	62	64	67	69	72	74	77	79	82	84	87	89	92	94	97	99
160.0	46	49	51	54	56	59	61	64	66	69	72	74	77	79	82	84	87	89	92	94	97	100	102
162.5	48	50	53	55	58	61	64	66	68	71	74	77	79	82	84	87	89	93	95	98	100	103	105
165.0	49	52	54	57	60	63	65	68	71	73	76	79	82	84	87	90	93	95	98	101	103	106	109
167.5	51	54	56	59	62	64	67	70	73	76	78	81	84	87	90	93	95	98	101	104	107	109	112
170.0	52	55	58	61	64	66	69	72	75	78	81	84	87	90	93	96	98	101	104	107	110	113	116
172.5	54	57	59	63	65	68	72	74	78	80	83	86	89	92	95	98	101	104	107	110	113	116	119
175.0	55	58	61	64	68	70	73	77	80	83	86	89	92	95	98	101	104	107	110	113	117	119	122
177.5	57	60	63	66	69	73	76	79	82	85	88	92	95	98	101	104	107	110	113	117	120	123	126
180.0	59	62	65	68	71	75	78	81	84	88	91	94	98	101	104	107	110	113	117	120	123	127	130
182.5	60	64	67	70	73	77	80	83	87	90	93	97	100	103	107	110	113	117	120	123	127	130	133
185.0	62	65	68	72	75	79	83	86	89	93	96	99	103	107	110	113	117	120	123	127	131	134	137
187.5	64	67	70	74	78	81	84	88	92	95	99	102	106	109	113	116	120	123	127	130	134	137	141
190.0	65	69	73	76	80	83	87	91	94	98	102	105	109	112	116	120	123	127	130	134	137	141	145
192.5	67	71	74	78	82	86	89	93	97	100	104	108	112	115	119	123	127	130	134	138	142	145	149
195.0	68	73	76	80	84	88	92	95	99	103	107	111	114	118	122	126	130	133	137	141	145	149	152
197.5	70	74	78	82	86	90	94	98	102	106	109	113	117	121	125	129	133	137	141	145	149	152	156
200.0	72	76	80	84	88	92	96	100	104	108	111	115	119	123	127	131	135	139	143	147	151	154	158
	Underweight (<18.5)	**Healthy weight** (18.5–24.9)						**Overweight** (25–29.9)					**Obese** (≥30)										

3

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3rd Edition
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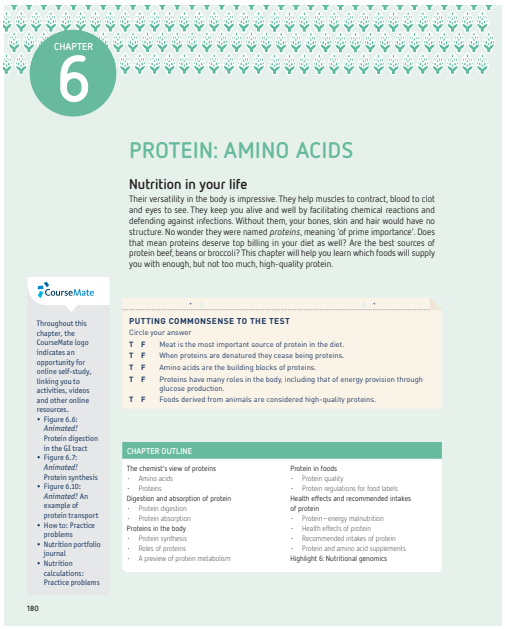
BRIEF CONTENTS

CONTENTS

Guide to the text

As you read this text you will find a number of features in every chapter to enhance your study of **nutrition** and help you understand how the theory is applied in the real world.

CHAPTER OPENING FEATURES


CHAPTER 6

PROTEIN: AMINO ACIDS

Nutrition in your life

Their versatility in the body is impressive. They help muscles to contract, blood to clot and eyes to see. They keep you alive and well by facilitating chemical reactions and defending against infections. Without them, your bones, skin and hair would have no structure. No wonder they were named *proteins*, meaning 'of prime importance'. Does that mean proteins deserve top billing in your diet as well? Are the best sources of protein beef, beans or broccoli? This chapter will help you learn which foods will supply you with enough, but not too much, high-quality protein.

CourseMate

Throughout this chapter, the CourseMate logo indicates an opportunity for online self-study, linking you to activities, videos and other online resources.
- Figure 6.6: *Animated!* Protein digestion in the GI tract
- Figure 6.7: *Animated!* Protein synthesis
- Figure 6.10: *Animated!* An example of protein transport
- How to: Practice problems
- Nutrition portfolio journal
- Nutrition calculations: Practice problems

PUTTING COMMONSENSE TO THE TEST

Circle your answer

T F Meat is the most important source of protein in the diet.
T F When proteins are denatured they cease being proteins.
T F Amino acids are the building blocks of proteins.
T F Proteins have many roles in the body, including that of energy provision through glucose production.
T F Foods derived from animals are considered high-quality proteins.

CHAPTER OUTLINE

The chemist's view of proteins
- Amino acids
- Proteins

Digestion and absorption of protein
- Protein digestion
- Protein absorption

Proteins in the body
- Protein synthesis
- Roles of proteins
- A preview of protein metabolism

Protein in foods
- Protein quality
- Protein regulations for food labels

Health effects and recommended intakes of protein
- Protein–energy malnutrition
- Health effects of protein
- Recommended intakes of protein
- Protein and amino acid supplements

Highlight 6: Nutritional genomics

180

Connect **Nutrition in your life** with the essential chapter concepts right from the beginning of each chapter.

NEW

PUTTING COMMON SENSE TO THE TEST

The *Australian Guide to Healthy Eating* prescribes a set diet.

FALSE

Think about your intuitive beliefs related to the nutrition topics covered in the chapter by taking the **Commonsense test** at the start of every chapter. Check your answers in the margins when the topic is discussed, which are explained further in the end-of-chapter review.

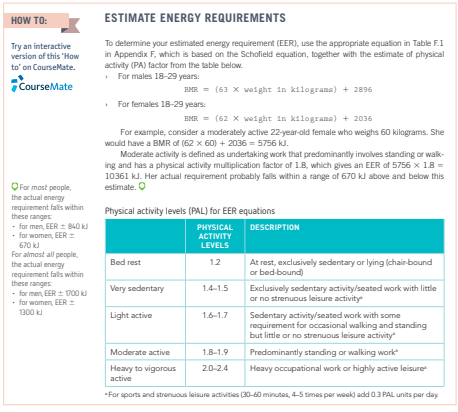
CourseMate

Preview the key interactive elements in each chapter with the **CourseMate** guide.

FEATURES WITHIN CHAPTERS

HOW TO:

Practise common nutrition tasks such as comparing nutrient density or calculating your energy requirements by working through the **How to** boxes that appear throughout the book.


HOW TO:

ESTIMATE ENERGY REQUIREMENTS

Try an interactive version of this 'How to' on CourseMate.

To determine your estimated energy requirement (EER), use the appropriate equation in Table F.1 in Appendix F, which is based on the Schofield equation, together with the estimate of physical activity (PA) factor from the table below.

› For males 18–29 years:

BMR = (63 × weight in kilograms) + 2896

› For females 18–29 years:

BMR = (62 × weight in kilograms) + 2036

For example, consider a moderately active 22-year-old female who weighs 60 kilograms. She would have a BMR of (62 × 60) + 2036 = 5756 kJ.

Moderate activity is defined as undertaking work that predominantly involves standing or walking and has a physical activity multiplication factor of 1.8, which gives an EER of 5756 × 1.8 = 10361 kJ. Her actual requirement probably falls within a range of 670 kJ above and below this estimate.

For *most* people, the actual energy requirement falls within these ranges:
- for men, EER ± 840 kJ
- for women, EER ± 670 kJ

For *almost all* people, the actual energy requirement falls within these ranges:
- for men, EER ± 1700 kJ
- for women, EER ± 1300 kJ

Physical activity levels (PAL) for EER equations

	PHYSICAL ACTIVITY LEVELS	DESCRIPTION
Bed rest	1.2	At rest, exclusively sedentary or lying (chair-bound or bed-bound)
Very sedentary	1.4–1.5	Exclusively sedentary activity/seated work with little or no strenuous leisure activity*
Light active	1.6–1.7	Sedentary activity/seated work with some requirement for occasional walking and standing but little or no strenuous leisure activity*
Moderate active	1.8–1.9	Predominantly standing or walking work*
Heavy to vigorous active	2.0–2.4	Heavy occupational work or highly active leisure*

*For sports and strenuous leisure activities (30–60 minutes, 4–5 times per week) add 0.3 PAL units per day.

A well-planned diet delivers adequate nutrients, a balanced array of nutrients, and an appropriate amount of energy.

REVIEW IT

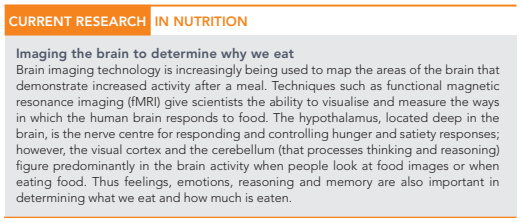
Use the *Australian Guide to Healthy Eating* to develop a meal plan within a specified energy allowance.

LEARN IT

Identify key concepts through the **Learn it** objectives, then revise what you have learnt with the **Review it** summaries that list key points from the section.

CURRENT RESEARCH IN NUTRITION

Explore relevant and up-to-date nutrition research in the **Current research in nutrition** boxes.



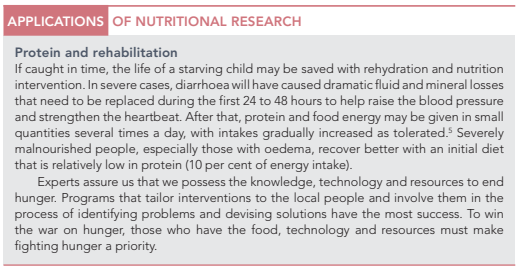
CURRENT RESEARCH IN NUTRITION

Imaging the brain to determine why we eat

Brain imaging technology is increasingly being used to map the areas of the brain that demonstrate increased activity after a meal. Techniques such as functional magnetic resonance imaging (fMRI) give scientists the ability to visualise and measure the ways in which the human brain responds to food. The hypothalamus, located deep in the brain, is the nerve centre for responding and controlling hunger and satiety responses; however, the visual cortex and the cerebellum (that processes thinking and reasoning) figure predominantly in the brain activity when people look at food images or when eating food. Thus feelings, emotions, reasoning and memory are also important in determining what we eat and how much is eaten.

APPLICATIONS OF NUTRITION RESEARCH

Evaluate how current research in the field informs our practical health and food choices in the **Applications of nutrition research** boxes.



APPLICATIONS OF NUTRITIONAL RESEARCH

Protein and rehabilitation

If caught in time, the life of a starving child may be saved with rehydration and nutrition intervention. In severe cases, diarrhoea will have caused dramatic fluid and mineral losses that need to be replaced during the first 24 to 48 hours to help raise the blood pressure and strengthen the heartbeat. After that, protein and food energy may be given in small quantities several times a day, with intakes gradually increased as tolerated.[5] Severely malnourished people, especially those with oedema, recover better with an initial diet that is relatively low in protein (10 per cent of energy intake).

Experts assure us that we possess the knowledge, technology and resources to end hunger. Programs that tailor interventions to the local people and involve them in the process of identifying problems and devising solutions have the most success. To win the war on hunger, those who have the food, technology and resources must make fighting hunger a priority.

Extend your learning with the additional information notes, which highlight interesting or important points about the topic being discussed.

Moderation contributes to adequacy, balance, and energy control.

Navigate the online resources by following the **CourseMate margin icons** throughout the text. Find answers, activities, videos and more.

CourseMate

Practise this calculation with the 'How to' activity on the CourseMate website.

DIETARY GUIDELINES

AUSTRALIAN DIETARY GUIDELINES

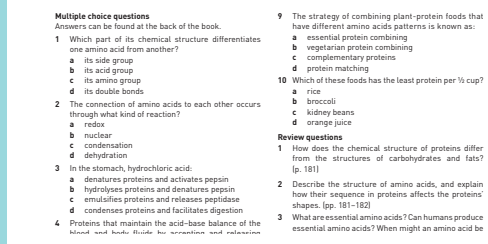
Meet recommended intakes within energy needs by adopting a balanced eating pattern, such as the *Australian Guide to Healthy Eating* or the DASH eating plan.

Connect key **Australian Dietary Guidelines** to your understanding of the chapter.

END-OF-CHAPTER FEATURES

At the end of each chapter you'll find several tools to help you to review, practise and extend your knowledge of the key learning outcomes.

STUDY QUESTIONS



Multiple choice questions
Answers can be found at the back of the book.

1 Which part of its chemical structure differentiates one amino acid from another?
- **a** its side group
- **b** its acid group
- **c** its amino group
- **d** its double bonds

2 The connection of amino acids to each other occurs through what kind of reaction?
- **a** redox
- **b** nuclear
- **c** condensation
- **d** dehydration

3 In the stomach, hydrochloric acid:
- **a** denatures proteins and activates pepsin
- **b** hydrolyses proteins and denatures pepsin
- **c** emulsifies proteins and releases peptidase
- **d** condenses proteins and facilitates digestion

4 Proteins that maintain the acid–base balance of the blood and body fluids by accepting and releasing

9 The strategy of combining plant-protein foods that have different amino acids patterns is known as:
- **a** essential protein combining
- **b** vegetarian protein combining
- **c** complementary proteins
- **d** protein matching

10 Which of these foods has the least protein per ½ cup?
- **a** rice
- **b** broccoli
- **c** kidney beans
- **d** orange juice

Review questions

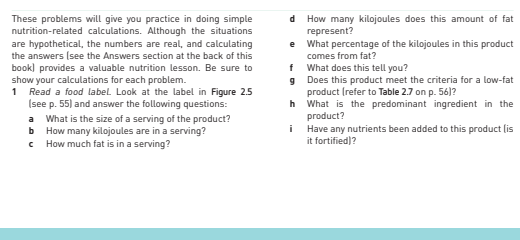
1 How does the chemical structure of proteins differ from the structures of carbohydrates and fats? (p. 181)

2 Describe the structure of amino acids, and explain how their sequence in proteins affects the proteins' shapes. (pp. 181–182)

3 What are essential amino acids? Can humans produce essential amino acids? When might an amino acid be

- Review the major chapter concepts in preparation for exams by completing the **Study questions**.

NUTRITION CALCULATIONS



These problems will give you practice in doing simple nutrition-related calculations. Although the situations are hypothetical, the numbers are real, and calculating the answers (see the Answers section at the back of this book) provides a valuable nutrition lesson. Be sure to show your calculations for each problem.

1 *Read a food label.* Look at the label in **Figure 2.5** (see p. 55) and answer the following questions:
- **a** What is the size of a serving of the product?
- **b** How many kilojoules are in a serving?
- **c** How much fat is in a serving?
- **d** How many kilojoules does this amount of fat represent?
- **e** What percentage of the kilojoules in this product comes from fat?
- **f** What does this tell you?
- **g** Does this product meet the criteria for a low-fat product (refer to **Table 2.7** on p. 56)?
- **h** What is the predominant ingredient in the product?
- **i** Have any nutrients been added to this product (is it fortified)?

- Master the common **Nutrition calculations** introduced in the **How to** chapter feature.

NUTRITION ON THE NET

NUTRITION ON THE NET

Analyse the nutrient composition of foods online: To learn more about the nutrient content of the foods you eat, you can access the full NUTTAB Food Composition Database provided by Food Standards Australia New Zealand from http://www.foodstandards.gov.au/science/monitoringnutrients/nutrientables
- Search for 'food labels' at the FSANZ website: http://www.foodstandards.gov.au
- Learn more about the *Australian Guide to Healthy Eating*: https://www.eatforhealth.gov.au/guidelines/australian-guide-healthy-eating
- Find New Zealand information on nutrition guidelines and food labels at http://www.foodstandards.govt.nz
- Learn more about the healthy eating pyramid: http://www.nutritionaustralia.org
- Visit the Traditional Diet Pyramids for various ethnic groups at Oldways Preservation and Exchange Trust: http://www.oldwayspt.org
- Visit the United States Department of Agriculture website and view 'My Plate': http://www.cnpp.usda.gov/MyPlate and compare it to the Australian version
- Search for 'food labels' at the International Food Information Council Foundation: http://www.ific.org
- Read about the Health Star Rating which is now on many New Zealand and Australian packaged foods: http://healthstarrating.gov.au/internet/healthstarrating/publishing.nsf/content/home
- Get healthy eating tips from the 'Go for 2&5' program: http://www.gofor2and5.com.au
- Learn more about the Australian Dietary Guidelines at: http://www.eatforhealth.gov.au

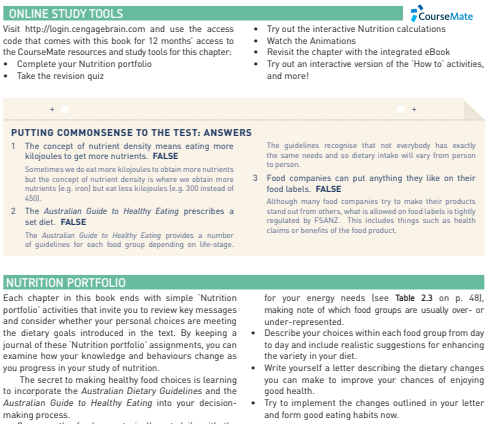
SEARCH ME! NUTRITION

Keyword: **food labels**

Interpreting food labelling can be a confusing task for most people trying to make sense of all the nutritional information. Read the article *Australian consumers are sceptical about but influenced by claims about fat on food labels*. What food label claims do consumers find most and least useful?

- Expand your knowledge by exploring the online resources listed in **Nutrition on the net** and by completing the **Search me! nutrition** research activity.

NUTRITION PORTFOLIO



ONLINE STUDY TOOLS

Visit http://login.cengagebrain.com and use the access code that comes with this book for 12 months' access to the CourseMate resources and study tools for this chapter:
- Complete your Nutrition portfolio
- Take the revision quiz
- Try out the interactive Nutrition calculations
- Watch the Animations
- Revisit the chapter with the integrated eBook
- Try out an interactive version of the 'How to' activities, and more!

PUTTING COMMONSENSE TO THE TEST: ANSWERS

1 The concept of nutrient density means eating more kilojoules to get more nutrients. **FALSE**
Sometimes we do eat more kilojoules to obtain more nutrients but the concept of nutrient density is where we obtain more nutrients (e.g. iron) but eat less kilojoules (e.g. 300 instead of 450).

2 The *Australian Guide to Healthy Eating* prescribes a set diet. **FALSE**
The *Australian Guide to Healthy Eating* provides a number of guidelines for each food group depending on life-stage. The guidelines recognise that not everybody has exactly the same needs and so dietary intake will vary from person to person.

3 Food companies can put anything they like on their food labels. **FALSE**
Although many food companies try to make their products stand out from others, what is allowed on food labels is tightly regulated by FSANZ. This includes things such as health claims or benefits of the food product.

NUTRITION PORTFOLIO

Each chapter in this book ends with simple 'Nutrition portfolio' activities that invite you to review key messages and consider whether your personal choices are meeting the dietary goals introduced in the text. By keeping a journal of these 'Nutrition portfolio' assignments, you can examine how your knowledge and behaviours change as you progress in your study of nutrition.

The secret to making healthy food choices is learning to incorporate the *Australian Dietary Guidelines* and the *Australian Guide to Healthy Eating* into your decision-making process.
- Compare the foods you typically eat daily with the *Australian Guide to Healthy Eating* recommendations for your energy needs (see **Table 2.3** on p. 48), making note of which food groups are usually over- or under-represented.
- Describe your choices within each food group from day to day and include realistic suggestions for enhancing the variety in your diet.
- Write yourself a letter describing the dietary changes you can make to improve your chances of enjoying good health.
- Try to implement the changes outlined in your letter and form good eating habits now.

- Reflect on your own personal nutritional choices in the **Nutrition portfolio** section.

HIGHLIGHTS

Every chapter is followed by a highlight that provides readers with an in-depth look at a current and often controversial topic that relates to its companion chapter.

HIGHLIGHT 2

NUTRITIONAL GENOMICS

LEARNING OBJECTIVE
Explain how nutrients influence gene activity (nutrigenomics) and how genes influence the activities of nutrients (nutrigenetics).

Imagine this scenario: A physician scrapes a sample of cells from inside your cheek and submits it to a **genomics** lab. The lab returns a report based on your genetic profile that reveals which diseases you are most likely to develop and makes recommendations for specific diet and lifestyle changes that can help you maintain good health. You may also be given a prescription for a dietary supplement that will best meet your personal nutrient requirements. Such a scenario may one day become reality as scientists uncover the genetic relationships between diet and disease. (Until then, however, consumers need to know that current genetic test kits commonly available on the Internet are unproven and quite likely fraudulent.)

Shutterstock.com/Steven P Baker

Can your specific diet and lifestyle needs be decided in a laboratory?

How nutrients influence gene activity and how **genes** influence the activities of nutrients is the focus of a new field of study called **nutritional genomics**. Unlike sciences in the 20th century, nutritional genomics takes a comprehensive approach in analysing information from several fields of study, providing an integrated understanding of the findings. Consider how multiple disciplines contributed to our understanding of vitamin A over the past several decades, for example. Biochemistry revealed vitamin A's three chemical structures. Immunology identified the anti-infective properties of one of these structures, while physiology focused on another structure and its role in vision. Epidemiology has reported improvements in the death rates and vision of malnourished children given vitamin A supplements, and biology has explored how such effects might be possible. The process was slow as researchers collected information on one gene, one action and one nutrient at a time. Today's research in nutritional genomics involves all of the sciences, coordinating their multiple findings, and explaining their interactions among several genes, actions and nutrients in relatively little time. As a result, nutrition knowledge is growing at an incredibly fast pace.

The recent surge in genomics research grew from the Human Genome Project, an international effort by industry and government scientists to identify and describe all of the genes in the **human genome** – that is, all the genetic information contained within a person's cells. Completed in 2003, this project developed many of the research technologies needed to study genes and genetic variation. Scientists are now working to identify the individual proteins made by the genes, the genes associated with diseases, and the dietary and lifestyle choices that most influence the expression of those genes. Such information will have major implications for society in general, and for healthcare in particular.[1]

A GENOMICS PRIMER

Figure H6.1 shows the relationships among the materials that comprise the genome. As the discussion of protein synthesis in Chapter 6 points out, genetic information is encoded in DNA molecules within the nucleus of cells. The DNA molecules and associated proteins are packed within 46 **chromosomes**. The genes are segments of a DNA strand that can eventually be translated into one or more proteins. The sequence of **nucleotide bases** within each gene determines the amino acid sequence of a particular protein. Scientists currently estimate that there are between 20 000 and 25 000 genes in the human genome.

HIGHLIGHT ACTIVITIES

CRITICAL THINKING QUESTIONS

A What are the strengths and weaknesses of vegetarian diets?

B Your interest in nutrition has been piqued by the concept of a vegetarian diet, and you wisely recognise that a well-planned diet involves more than simply replacing a turkey sandwich with peanut butter crackers. Design and follow a vegetarian meal plan for three days, including at least one vegan day. Outline the social, personal, and nutritional challenges you faced and describe how you might partially or fully integrate vegetarian meals into your current meal plan.

NUTRITION ON THE NET

Analyse the nutrient composition of foods online: To learn more about the nutrient content of the foods you eat, you can access the full NUTTAB Food Composition Database provided by Food Standards Australia New Zealand from http://www.foodstandards.gov.au/science/monitoringnutrients/nutrientables

- Search for 'vegetarian' at the US Food and Drug Administration's site: http://www.fda.gov
- Visit the site of the Australian Vegetarian and Vegan Society: http://www.vegsa.org.au
- Review another vegetarian diet pyramid developed by Oldways Preservation & Exchange Trust: http://www.oldwayspt.org

- Develop your understanding of these key topics by responding to the **Critical thinking questions**.
- Research these thought-provoking topics further by exploring the weblinks listed in **Nutrition on the net**.

Guide to the online resources

FOR THE INSTRUCTOR

Cengage Learning is pleased to provide you with a selection of resources that will help you prepare your lectures and assessments. These teaching tools are accessible via cengage.com.au/instructors for Australia or cengage.co.nz/instructors for New Zealand.

MindTap

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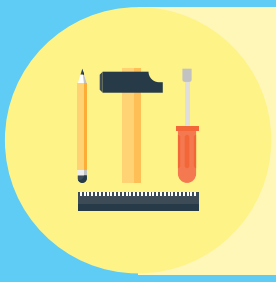

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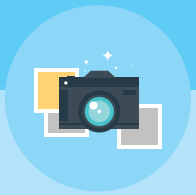

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FEATURES MATRIX

CHAPTER	HOW TO	APPLICATIONS OF NUTRITIONAL RESEARCH	CURRENT RESEARCH IN NUTRITION	ANIMATED FIGURES
1	Calculate the energy available from foods Determine whether a website is reliable Find credible sources of nutrition information	The key dietary patterns of long-term health	Using the energy density of foods to eat less	
2	Compare foods based on nutrient density			
3		The myth of 'food combining'	Stomach hormones	Figure 3.7 The digestive fate of a sandwich Figure 3.10 The vascular system
4	Reduce the intake of added sugars	Diabetes and glycaemic index	Fructose and FODMAPS	Figure 4.10 Carbohydrate digestion in the GI tract
5	Make heart-healthy choices – by food group	Mediterranean diet and health	Omega-3s and brain development	Figure 5.15 Absorption of fat
6		Protein and rehabilitation	Fighting sarcopenia	Figure 6.6 Protein digestion in the GI tract Figure 6.7 Protein synthesis Figure 6.10 An example of protein transport
7		Identifying a fad diet	Leaky mitochondria and body heat	Figure 7.5 Glycolysis: glucose to pyruvate Figure 7.9 Fatty acid to acetyl CoA Figure 7.10 Fats enter the energy pathway Figure 7.18 The TCA cycle Figure 7.19 Electron transport chain and ATP synthesis
8	Estimate energy requirements	What makes us feel full? Childhood obesity	Imaging the brain to determine why we eat	
9	Compare foods based on energy density Identify a fad diet or weight-loss scam	Mindful eaters eat less How water helps you feel full Being active boosts metabolism	Hunger hormones make long-term weight loss difficult Is 'fat and fit' a myth?	Figure 9.7 Influence of physical activity on discretionary kilojoule allowance

CHAPTER	HOW TO	APPLICATIONS OF NUTRITIONAL RESEARCH	CURRENT RESEARCH IN NUTRITION	ANIMATED FIGURES
10	Understand dose levels and effects Evaluate foods for their nutrient contributions Estimate niacin equivalents Estimate dietary folate equivalents	Using niacin to prevent heart disease	Folic acid supplements appear safe for all Can vitamin C cure the common cold?	Figure 10.1 Coenzyme action Figure 10.12 Metabolic pathways involving B group vitamins
11		Foods trump supplements when it comes to antioxidants in our diet	Using vitamin D to reduce falls in the elderly Fat-soluble vitamin deficiency a risk in cystic fibrosis	Figure 11.3 Vitamin A's role in vision Figure 11.9 Vitamin D synthesis and activation
12	Cut salt (and sodium) intake Estimate your calcium intake	Do we really need '8 glasses of water' each day? A diet to lower blood pressure	Dietary potassium linked to a longer life Magnesium supplements and muscle cramps	Figure 12.2 A nephron, one of the kidney's many functioning units Figure 12.3 How the body regulates blood volume Figure 12.12 Calcium balance
13	Estimate the recommended daily intake for iron	The key dietary factors that affect iron absorption	Zinc and the common cold	Figure 13.3 Iron recycled in the body Figure 13.6 Enteropancreatic circulation of zinc
14	Maximise glycogen stores: carbohydrate loading Evaluate sports drinks	Hyponatraemia	Strength training for the elderly	Figure 14.1 Delivery of oxygen by the heart and lungs to the muscles
15		Vitamin D deficiency in pregnancy	Folic acid in pregnancy	
16	Plot measures on a growth chart	Fathers and children's diets	Fruit juice and childhood adiposity	
17		Glucosamine and chondroitin treatments for osteoarthritis Undernutrition in the elderly	Delaying ageing through energy restriction	
18	Assess your risk of heart disease Implement a heart-healthy diet	Fibre intake and diabetes control	Fructose and blood pressure	
19	Prevent food-borne illness Prepare foods to minimise pesticide residues	Antimicrobial properties of plants	Antimicrobial plastic wrap	
Appendix D	Measure protein quality using PDCAAS			

PREFACE

Nutrition is a science. The details of a nutrient's chemistry or a cell's biology can be overwhelming and confusing to some, but it needn't be. When the science is explained step by step and the facts are connected one by one, the details become clear and understandable. That has been the goal since the book was first developed and continues to be updated in this third edition: to reveal the fascination of science and share the excitement of nutrition with readers. We have learned from the hundreds of university teachers and nutrition professionals and more than a million students who have used previous editions of this book through the years that readers want to *understand* nutrition so that they can make healthy choices in their daily lives.

With its focus on Australia and New Zealand, the text incorporates current nutrition recommendations and public health issues, and food culture relevant to those studying and working in nutrition in this region of the world.

Because nutrition is an active science, staying current is paramount. To that end, this edition incorporates the latest in nutrition research. The connections between diet and disease have become more apparent – and our interest in making smart health choices has followed. More people are living longer and healthier lives. The science of nutrition has grown rapidly, with new research emerging daily. In this edition, as with previous editions, every chapter has been substantially revised to reflect the many changes that have occurred in the field of nutrition and in our daily lives over the years. We hope that this book serves you well.

THE CHAPTERS

Understanding Nutrition presents the core information of an introductory nutrition course. The early chapters introduce the nutrients and their work in the body, and the later chapters apply that information to people's lives – describing the role of foods and nutrients in energy balance and weight control, in physical activity, in the life cycle and in disease prevention, and food safety. Each chapter also clearly flags for the reader practical applications of nutrition research as well as presenting the most recent research in the topic area.

THE HIGHLIGHTS

Every chapter is followed by a highlight that provides readers with an in-depth look at a current, and often controversial, topic that relates to its companion chapter. Highlight 4 features vitamin D and the many health benefits now being linked to this 'sunshine vitamin'. New to this edition are Critical Thinking Questions designed to encourage readers to develop clear, rational, open-minded, and informed thoughts based on the evidence presented in the highlight.

THE APPENDICES

The appendices are valuable references for a number of purposes. Appendix A summarises background information on the hormonal and nervous systems, complementing Appendices B and C on basic chemistry, the chemical structures of nutrients and major metabolic pathways. Appendix D describes measures of protein quality. Appendix E provides detailed coverage of nutrition assessment, and Appendix F presents estimated energy requirements for men and women at various levels of physical activity. Appendix G presents common calculation and conversion tips.

THE COVERS

The inside of the covers puts commonly used information at your fingertips, including current nutrient recommendations, as well as suggested weight ranges for various heights.

We have taken great care to provide accurate information and have included many references at the end of the book. However, to keep the number of references manageable, many statements appear without references. All statements reflect current nutrition knowledge and the authors will supply references upon request. In addition to supporting text statements, the references provide readers with resources for finding a good overview or more details on the subject.

In this new edition, the art and layout have been carefully designed to be inviting while enhancing student learning. For all chapters and highlights, content has been reviewed and updated. Several new figures and tables have been created and others revised to enhance learning. Each chapter also features a true–false 'commonsense' test presented at the beginning to allow students to test their core knowledge on practical nutrition concepts related to the topic. Answers to these commonsense questions are revealed throughout the chapter and a brief explanation is given at the end. This new edition has also been revised throughout to include more content and related nutrition issues that are specific to New Zealand. For example, Chapter 2 features the newly released *Eating and Activity Guidelines for New Zealand Adults*. And to acknowledge the growing interest in the gastrointestinal microbiome in health, an expanded section in Chapter 3 has been added as well as a research focus in Chapter 4.

Nutrition is a fascinating subject, and we hope our enthusiasm for it comes through on every page.

Tim Crowe
David Cameron-Smith
Adam Walsh
Ellie Whitney
Sharon Rady Rolfes

ABOUT THE AUTHORS

Eleanor Noss Whitney, PhD, received her BA in Biology from Radcliffe College in 1960 and her PhD in Biology from Washington University, St Louis, in 1970. Formerly on the faculties at Florida State University and Florida A&M University and a dietitian registered with the American Dietetic Association, Ellie now devotes full time to research, writing and consulting in nutrition, health and environmental issues. Her earlier publications include articles in science, genetics, and other journals. Her textbooks include *Nutrition Concepts and Controversies* 12th edn, *Understanding Nutrition* 12th edn, *Understanding Normal and Clinical Nutrition* 9th edn and *Nutrition and Diet Therapy* 7th edn all with Cengage Wadsworth. She also recently co-authored *Priceless Florida* (Pineapple Press), a comprehensive text examining the ecosystems in her home state. Her additional interests include energy conservation, solar energy use, alternatively fuelled vehicles and ecosystem restoration.

Sharon Rady Rolfes received her MS in nutrition and food science from Florida State University. She is a founding member of Nutrition and Health Associates, an information resource centre that maintains a research database on over 1000 nutrition-related topics. Sharon's publications include the college textbooks *Understanding Nutrition* 12th edn and *Nutrition for Health and Health Care* 4th edn. In addition to writing and research, she occasionally teaches at Florida State University and serves as a consultant for various educational projects. Her volunteer work includes serving on the board of Working Well, a community initiative dedicated to creating a healthy workforce.

Associate Professor Tim Crowe is a nutrition academic at Deakin University in Melbourne and teaches across the undergraduate and postgraduate nutrition and dietetics programs. Tim teaches in the areas of nutritional physiology and biochemistry as well as the applied role of nutrition in disease prevention and management, particularly obesity, diabetes and cancer. He is actively involved in several areas of nutrition research including specialised nutrition in the prevention of surgical complications, nutrition support in wound healing, and also malnutrition identification. Tim is also an Advanced Accredited Practising Dietitian and speaks on many health topics to the public through both the media and writing for consumer publications.

Professor David Cameron-Smith is Chair in Nutrition and Research Director of the Liggins Institute, University of Auckland. He is a passionate researcher and educator, working to further how food has an impact on human biology and the biochemical links between nutrients and human health.

Adam Walsh is a lecturer in Nutrition and Dietetics in the School of Exercise and Nutrition Sciences at Deakin University in Melbourne. He teaches into the undergraduate and postgraduate nutrition and dietetics programs in the areas of clinical dietetics and paediatric health. Adam's area of research is the influence of fathers on young children's nutrition and physical activity behaviours.

ACKNOWLEDGEMENTS

The adaptation and updating of this textbook has been a team effort by the three of us, all focused on improving a book that has been well received throughout nutrition courses in Australia and New Zealand. Many thanks must go to the team of external reviewers who gave valuable feedback and advice on each of the chapters in order to improve the relevance of the text to the teaching of nutrition in Australia and New Zealand. The team at Cengage have been instrumental in guiding us through the entire process and have been a pleasure to work with through all stages of development. It is rewarding to see the text now in print after all our hard work.

From Tim Crowe: Many thanks go to my nutrition and dietetic friends and colleagues who have been down the publication path before and assured me that the late nights and long weekends of writing and proofing would be time well spent in producing a piece of work to be proud of.

From Adam Walsh: Thanks to my two wonderful boys for keeping me grounded. They have, on more than one occasion, reminded me that even though I'm the dietitian in the house, I'm still just Dad.

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CHAPTER 1

AN OVERVIEW OF NUTRITION

Nutrition in your life

Believe it or not, you have probably eaten at least 20 000 meals in your life. Without any conscious effort on your part, your body uses the nutrients from those meals to make all its components, fuel all its activities and defend itself against diseases. How successfully your body handles these tasks depends, in part, on your food choices. Nutritious food choices support healthy bodies.

PUTTING COMMONSENSE TO THE TEST

Circle your answer

T F What we eat is largely driven by how hungry we are.
T F Fat has twice the number of kilojoules as carbohydrates or protein.
T F All published research should be treated with some level of critical appraisal.
T F An RDI for a nutrient is the amount that everyone needs to consume each day.
T F Changing our diet will do little to reduce the risk of many chronic diseases.

CHAPTER OUTLINE

FOOD CHOICES

The nutrients
- Nutrients in foods and in the body
- Energy-yielding nutrients: carbohydrate, fat and protein
- Vitamins
- Minerals
- Water

The science of nutrition
- Conducting research
- Analysing research findings
- Evaluating the reliability of research

Nutrient reference values
- Establishing nutrient recommendations
- Establishing energy recommendations
- Using nutrient recommendations
- Comparing nutrient recommendations

Nutrition assessment
- Nutrition assessment of individuals
- Nutrition assessment of populations

Diet and health
- Chronic diseases
- Risk factors for chronic diseases

Highlight 1: Nutrition information and misinformation – on the net and in the news

CourseMate

Throughout this chapter, the CourseMate logo indicates an opportunity for online self-study, linking you to activities, videos and other online resources.
- How to: Practice problems
- Nutrition portfolio journal
- Nutrition calculations: Practice problems

Welcome to the world of **nutrition**. Although you may not always have been aware of it, nutrition has played a significant role in your life. And it will continue to affect you in major ways, depending on the **foods** you select.

Every day, several times a day, you make food choices that influence your body's health for better or worse. Each day's choices may benefit or harm your health only a little, but when these choices are repeated over years and decades, the rewards or consequences become major. That being the case, paying close attention to good eating habits now can bring you health benefits later. Conversely, carelessness about food choices can contribute to many chronic diseases prevalent in later life, including heart disease and cancer. Of course, some people will become ill or die young no matter what choices they make, and others will live long lives despite making poor choices. For the majority of us, however, the food choices we make each and every day will benefit or impair our health in proportion to the wisdom of those choices.

In general, a **chronic** disease progresses slowly or with little change and lasts a long time. By comparison, an **acute** disease develops quickly, produces sharp symptoms and runs a short course.
- *chronos* = time
- *acute* = sharp

Although most people realise that their food habits affect their health, they often choose foods for other reasons. After all, foods bring to the table a variety of pleasures, traditions and associations as well as nourishment. The challenge, then, is to combine favourite foods and fun times with a nutritionally balanced **diet**.

PUTTING COMMON-SENSE TO THE TEST

What we eat is largely driven by how hungry we are.

FALSE

FOOD CHOICES

LEARN IT

Describe how various factors influence personal food choices.

People decide what to eat, when to eat and even whether to eat in highly personal ways, often based on behavioural or social motives rather than on an awareness of nutrition's importance to health.

Many different food choices can support good health, and an understanding of nutrition will help you to make sensible selections more often.

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An enjoyable way to learn about other cultures is to taste their ethnic foods.

Personal preference

As you might expect, the primary reason people choose foods is taste – they like certain flavours. Two widely shared preferences are for the sweetness of sugar and for the savouriness of salt. Liking high-fat foods also appears to be a universally common preference. Other preferences might be for the hot chilli common in Mexican cooking or the curry spices of Indian cuisine. Some research suggests that genetics may influence people's food preferences.[1]

Habit

People sometimes select foods out of habit. They eat cereal every morning, for example, simply because they have always eaten cereal for breakfast. Eating a familiar food and not having to make any decisions can be comforting.

Ethnic heritage or tradition

Among the strongest influences on food choices are ethnic heritage and tradition. People eat the foods they grew up eating. Every country, and in fact every region of a country, has its own typical foods and ways of combining them into meals. The 'Australian diet' includes many ethnic foods from various countries, such as Greece, Italy, Thailand and China, all adding variety to the diet. The New Zealand diet has been influenced by British, Pacific and, more recently, Asian migrants. Recent trends in the New Zealand diet include a reduction in beef, lamb and potatoes and an

increase in poultry, pasta and rice which is a reflection of international food trends, food prices and ease of preparation.[2]

Social interactions

Most people enjoy companionship while eating. It's fun to go out with friends for pizza or Thai. Meals are social events, and sharing food is part of hospitality. Social customs invite people to accept food or drink offered by a host or shared by a group.

Availability, convenience and economy

People eat foods that are accessible, quick and easy to prepare, and within their financial means. Today's consumers value convenience and are willing to spend more than half of their food budget on meals that require little, if any, further preparation.[3] They frequently eat out, bring home ready-to-eat meals or have food delivered. Even when they venture into the kitchen, they want to prepare a meal in 15 to 20 minutes, using less than half a dozen ingredients – and those 'ingredients' are often semiprepared foods, such as canned soups. This emphasis on convenience limits food choices to the selections offered on menus and products designed for quick preparation. Whether decisions based on convenience meet a person's nutrition needs depends on the choices made. Eating a banana or a chocolate bar may be equally convenient, but the fruit offers more vitamins and minerals and less sugar and fat.

Positive and negative associations

People tend to like particular foods associated with happy occasions – such as meat pies at football games or cake at birthday parties. By the same token, people can develop aversions and dislike foods that they ate when they felt sick or that were forced on them.[4] By using foods as rewards or punishments, parents may inadvertently teach their children to like and dislike certain foods.

Emotional comfort

Some people cannot eat when they are emotionally upset. Others may eat in response to a variety of emotional stimuli – for example, to relieve boredom or depression, or to calm anxiety.[5] A depressed person may choose to eat rather than to call a friend. A person who has returned home from an exciting evening out may unwind with a late-night snack. These people may find emotional comfort, in part, because foods can influence the brain's chemistry and the mind's response. Eating in response to emotions can easily lead to overeating and obesity, but it may be appropriate at times. For example, sharing food at times of grief serves both the giver's need to provide comfort and the receiver's need to be cared for and to interact with others, as well as to take nourishment.

Values

Food choices may reflect people's religious beliefs, political views or environmental concerns. For example, many Christians forgo meat during Lent (the period prior to Easter), Jewish law includes an

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To enhance your health, keep nutrition in mind when selecting foods.

extensive set of dietary rules that govern the use of foods derived from animals and Muslims fast between sunrise and sunset during Ramadan (the ninth month of the Islamic calendar). A concerned consumer may boycott fruit picked by migrant workers who have been exploited. People may buy vegetables from local farmers to save the fuel and environmental costs of foods shipped in from far away. They may also select foods packaged in containers that can be reused or recycled. Some consumers accept or reject foods that have been irradiated or genetically modified, depending on their approval of these processes (see Chapter and Highlight 19 for a complete discussion).

Nutrition and health benefits

Finally, of course, many consumers make food choices that will benefit health. Food manufacturers and restaurant chefs have responded to scientific findings linking health with nutrition by offering an abundant selection of health-promoting foods and beverages. Foods that provide health benefits beyond their nutrient contributions are called **functional foods**.[6] Whole foods – as natural and familiar as oats or tomatoes – are the simplest functional foods. In other cases, foods have been modified to provide health benefits, perhaps by lowering the fat content. In still other cases, manufacturers have fortified foods by adding **nutrients** or **phytochemicals** that provide health benefits (see Highlight 13). Examples of these functional foods include bread with omega-3 fish oil added to help promote a healthy heart, and margarine with added plant sterol that lowers blood cholesterol.

Functional foods may include whole foods, modified foods or fortified foods.

Consumers typically welcome new foods into their diets, provided that these foods are reasonably priced, clearly labelled, easy to find in the supermarket and convenient to prepare. These foods must also taste good – as good as the traditional choices. Of course, a person need not eat any of these 'special' foods to enjoy a healthy diet; many 'regular' foods provide numerous health benefits as well. In fact, 'regular' foods such as whole grains; vegetables and legumes; fruits; meats, fish and poultry; and milk products are among the healthiest choices a person can make.

REVIEW IT

A person selects foods for a variety of reasons. Whatever those reasons may be, food choices influence health. Individual food selections neither make nor break a diet's healthfulness, but the balance of foods selected over time can make an important difference to health. For this reason, people are wise to think 'nutrition' when making their food choices.

THE NUTRIENTS

LEARN IT

Name the six major classes of nutrients and identify which are organic and which yield energy.

Biologically speaking, people eat to receive nourishment. Do you ever think of yourself as a biological being made of carefully arranged atoms, molecules, cells, tissues and organs? Are you aware of the activity going on within your body even as you sit still? The atoms, molecules and cells of your body continually move and change, even though the structures of your tissues and organs and your external appearance remain relatively constant. Your skin, which has covered you since your birth, is replaced entirely by new cells every seven years. The fat beneath your skin is not the same fat that was there a year ago. Your oldest red blood cell is only 120 days old, and the entire lining of your digestive tract is renewed every three to five days. To maintain your 'self', you must continually replenish, from foods, the **energy** and the **nutrients** you deplete as your body maintains itself.

NUTRIENTS IN FOODS AND IN THE BODY

Amazingly, our bodies can derive all the energy, structural materials and regulating agents we need from the foods we eat. This section introduces the nutrients that foods deliver and shows how they participate in the dynamic processes that keep people alive and well.

Composition of foods

Chemical analysis of a food such as a tomato shows that it is composed primarily of water (95 per cent). Most of the solid materials are carbohydrates, lipids and proteins. If you could remove these materials, you would find a tiny residue of vitamins, minerals and other compounds. Water, carbohydrates, lipids, proteins, vitamins and some of the minerals found in foods are nutrients – substances the body uses for the growth, maintenance and repair of its tissues.

This book focuses mostly on the nutrients; however, foods contain other compounds as well – fibre, phytochemicals, pigments, additives, alcohols and others. Some are beneficial, some are neutral and a few are harmful. Later sections of the book touch on these compounds and their significance.

Composition of the body

A complete chemical analysis of your body would show that it is made of materials similar to those found in foods (see **Figure 1.1**). A healthy 70-kilogram body contains about 41 kilograms of water and about 9 to 21 kilograms of fat. The remaining kilograms are mostly protein, carbohydrate and the major minerals of the bones. Vitamins, other minerals and incidental extras constitute a fraction of a kilogram.

Chemical composition of nutrients

The simplest of the nutrients are the minerals. Each mineral is a chemical element; its atoms are all alike. As a result, its identity never changes. For example, iron may have different electrical charges, but the individual iron atoms remain the same when they are in a food, when a person eats the food, when the iron becomes part of a red blood cell, when the cell is broken down and when the iron is lost from the body by excretion. The next simplest nutrient is water, a compound made of two elements – hydrogen and oxygen. Minerals and water are **inorganic** nutrients, which means they do not contain carbon.

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FIGURE 1.1 Body composition of healthy-weight men and women

The human body is made of compounds similar to those found in foods – mostly water (60 per cent) and some fat (13 to 21 per cent for young men, 23 to 36 per cent for young women who are of a healthy weight), with carbohydrate, protein, vitamins, minerals and other minor constituents making up the remainder. (Chapter 8 describes the health hazards of too little or too much body fat.)

Key:
- % Carbohydrates, proteins, vitamins, minerals in the body
- % Fat in the body
- % Water in the body

Photodisc/Getty Images

As Chapter 5 explains, most lipids are fats.

The other four classes of nutrients (carbohydrates, lipids, proteins and vitamins) are more complex. In addition to hydrogen and oxygen, they all contain carbon, an element found in all living things. They are therefore called **organic** compounds (meaning, literally, *alive*). Protein and some vitamins also contain nitrogen and may contain other elements as well (see **Table 1.1**). The use of the term 'organic' when describing the chemistry of substances should not be confused with the use of this term in the farming and produce sense to describe how food is grown under a certification system.

TABLE 1.1 Elements in the six classes of nutrients

Notice that organic nutrients contain carbon.

	CARBON	HYDROGEN	OXYGEN	NITROGEN	MINERALS
Inorganic nutrients					
Minerals					✓
Water		✓	✓		
Organic nutrients					
Carbohydrates	✓	✓	✓		
Lipids (fats)	✓	✓	✓		
Proteins[a]	✓	✓	✓	✓	
Vitamins[b]	✓	✓	✓		

[a] Some proteins also contain the mineral sulphur.

[b] Some vitamins contain nitrogen; some contain minerals.

Essential nutrients

The body can make some nutrients, but it cannot make all of them. Also, it makes some in insufficient quantities to meet its needs and, therefore, must obtain these nutrients from foods. The nutrients that foods must supply are **essential nutrients**. When used to refer to nutrients, the word *essential* means more than just 'necessary'; it means 'needed from outside the body' – normally from foods.

ENERGY-YIELDING NUTRIENTS: CARBOHYDRATE, FAT AND PROTEIN

In the body, three organic nutrients can be used to provide energy: carbohydrate, fat and protein. In contrast to these **energy-yielding nutrients**, vitamins, minerals and water do not yield energy in the human body.

Carbohydrate, fat, and protein are sometimes called *macronutrients* because the body requires them in relatively large amounts (many grams daily). In contrast, vitamins and minerals are *micronutrients*, required only in small amounts (milligrams or micrograms daily). **Table 1.2** summarises some of the ways the six classes of nutrients can be described.

TABLE 1.2 The six classes of nutrients

NUTRIENT	ORGANIC	INORGANIC	ENERGY-YIELDING	MACRONUTRIENT	MICRONUTRIENT
Carbohydrates	✓		✓	✓	
Lipids (fats)	✓		✓	✓	
Proteins	✓		✓	✓	
Vitamins	✓				✓
Minerals		✓			✓
Water		✓			

Energy measured in kilojoules

The energy released from carbohydrates, fats and proteins can be measured in **joules**. In some countries (particularly the United States), 'calorie' is still the preferred measure of food energy, though in this context it is actually kilocalories (or kcalories) that is the implied unit of energy measure for food and the prefix of 'kilo' is normally dropped in everyday speaking. When you read in popular books or magazines that an apple provides '100 calories', it actually means 100 kcalories, which is the same as 420 kilojoules. This book uses the term kilojoules and its abbreviation kJ throughout.

The international unit for measuring food energy is the **joule**, a measure of work energy. The energy in food is normally expressed in **kilojoules**. To convert kcalories to kilojoules, multiply by 4.2; to convert kilojoules to kcalories, multiply by 0.24.

Energy from foods

The amount of energy a food provides depends on how much carbohydrate, fat and protein it contains. When completely broken down in the body, a gram of carbohydrate yields about 17 kilojoules (4 kcalories) of energy, a gram of protein also yields 17 kilojoules (4 kcalories) and a gram of fat yields 37 kilojoules (9 kcalories) (see **Table 1.3**). Fat, therefore, has a greater **energy density** than either carbohydrate or protein. The energy yield from carbohydrate of 17 kilojoules per gram is considered an average figure as monosaccharides (such as glucose), disaccharides (such as sucrose) and starch all yield slightly different amounts of energy per gram. The 'How to' box on page 9 explains how to calculate the energy available from foods.

TABLE 1.3 Kilojoule and kcalorie values of energy nutrients

Nutrients	Energy (kJ/g)	Energy (kcal/g)
Carbohydrate	17	4
Protein	17	4
Fat	37	9

NOTE: Alcohol contributes 29 kilojoules per gram that can be used for energy, but it is not considered a nutrient because it interferes with the body's growth, maintenance and repair.

One other substance contributes energy – alcohol. Alcohol is not considered a nutrient because it interferes with the growth, maintenance and repair of the body, but it does yield energy (29 kilojoules or 7 kcalories per gram) when metabolised in the body. (Highlight 7 and Chapter 18 present the potential harms and possible benefits of alcohol consumption.)

PUTTING COMMON-SENSE TO THE TEST

Fat has twice the number of kilojoules than carbohydrates or protein.

TRUE