

THE NUTRITION SOCIETY TEXTBOOK SERIES

Nutrition and Metabolism

Second Edition

Edited by
**Susan A Lanham-New,
Ian A Macdonald and Helen M Roche**

Contents

Contributors

Series Foreword

Preface

First Edition Acknowledgments

Dedication

1 Core Concepts of Nutrition

Ian A Macdonald and Michael J Gibney

1.1 Introduction

1.2 Balance

1.3 Turnover

1.4 Flux

1.5 Metabolic pools

1.6 Adaptation to altered nutrient supply

1.7 Perspectives on the future

2 Molecular Aspects of Nutrition

Helen M Roche, Herman E Popeijus and Ronald P Mensink

2.1 Introduction

2.2 Core concepts in molecular biology

2.3 Gene expression: transcription and translation

2.4 Research tools to investigate molecular aspects of nutrition

2.5 Genetic variability: determinants of health and response to nutrients

2.6 Nutrient regulation of gene expression

2.7 Perspectives on the future

3 Integration of Metabolism 1: Energy

Xavier M Leverve

3.1 Introduction

3.2 Energy metabolism at the cellular level

3.3 Energy metabolism in the body as a whole

3.4 Perspectives on the future

4 Integration of Metabolism 2: Macronutrients

Keith N Frayn and Abayomi O Akanji

4.1 Introduction: fuel intake and fuel utilisation

4.2 Regulatory mechanisms

4.3 Hormones that regulate macronutrient metabolism

4.4 Macronutrient metabolism in the major organs and tissues

4.5 Substrate fluxes in the overnight fasting state

4.6 Postprandial substrate disposal

4.7 Short-term and longer-term starvation

4.8 Perspectives on the future

5 Integration of Metabolism 3:

Protein and Amino Acids

Margaret E Brosnan, John T Brosnan and Vernon R Young With grateful appreciation to the outstanding work of Dr Vernon Young formally of MIT, USA (1937-2004)

5.1 Introduction

5.2 Protein and amino acid turnover

5.3 Protein synthesis

5.4 Regulation of the translation phase of protein synthesis

5.5 Post-translational events

5.6 Protein degradation

5.7 Selectivity of protein turnover

5.8 An integration of these processes of turnover with respect to amino acid metabolism

5.9 Regulation of amino acid metabolism

5.10 Amino acid synthesis: the dispensable amino acids

5.11 In vivo aspects of protein and amino acid turnover

5.12 In vivo rates of protein turnover

5.13 Mechanisms and factors responsible for alterations in protein turnover

5.14 Interorgan amino acid metabolism

5.15 Amino acid and peptide transport

5.16 Disposal of dietary amino acids and roles of specific organs

5.17 Catabolic illnesses

5.18 Non-proteinogenic metabolic functions of amino acids

5.19 Perspectives on the future

6 Pregnancy and Lactation

Joop MA van Raaij and Lisette CPGM de Groot

6.1 Pregnancy

6.2 Lactation

6.4 Perspectives on the future

7 Growth and Ageing

Mark L Wahlqvist and Prasong Tienboon

7.1 Introduction

7.2 Growth and development

7.3 Nutritional factors affecting growth

7.4 Nutrition and the life cycle

7.5 Effects of undernutrition

7.6 Effects of overnutrition

7.7 Growth during childhood and adolescence

7.8 Ageing

7.9 Guidelines for healthy ageing

7.10 Perspectives on the future

8 Nutrition and the Brain

John D Fernstrom and Madelyn H Fernstrom

8.1 Introduction

8.2 General organisation of the mammalian nervous system

8.3 The blood-brain barrier

8.4 Energy substrates

8.5 Amino acids and protein

8.6 Vitamins and minerals

8.7 Perspectives on the future

9 The Sensory Systems and Food Palatability

Conor M Delahunty

9.1 Introduction to the sensory systems

9.2 The taste system

9.3 The olfactory system

9.4 Smell mixtures

9.5 Chemesthesis

9.6 Texture

9.7 Role of saliva

9.8 Vision

9.9 Adaptation

9.10 Cross-modal sensory interactions

9.11 Food preferences

9.12 Changing function of the senses across the lifespan

9.13 Future perspectives

10 The Gastrointestinal Tract

Mariano Mañas, Emilio Martínez de Victoria, Angel Gil, María D Yago and John C Mathers

10.1 Introduction

10.2 Structure and function of the gastrointestinal system

10.3 Motility

10.4 Secretion

10.5 Digestion and absorption

10.6 Water balance in the gastrointestinal tract

10.7 The exocrine pancreas

10.8 Diet and exocrine pancreatic function

10.9 Interactions between the endocrine and exocrine pancreas

10.10 Physiology of bile secretion and enterohepatic circulation

10.11 Adaptation of the biliary response to the diet

10.12 Growth, development and differentiation of the gastrointestinal tract

10.13 The large bowel

10.14 Future directions

11 The Cardiovascular System

Gabriele Riccardi, Angela A Rivellese and Christine M Williams

11.1 Introduction

11.2 Factors involved in a healthy vascular system

11.3 Pathogenesis of cardiovascular disease

11.4 Risk factors for cardiovascular disease

11.5 Dietary components and their effect on plasma lipids

11.6 Diet and blood pressure

11.7 Effects of dietary factors on coagulation and fibrinolysis

11.8 Homocysteine

11.9 Diet and antioxidant function

11.10 Insulin sensitivity

11.11 Perspectives on the future

12 The Skeletal System

John M Pettifor, Ann Prentice, Kate Ward and Peter Cleaton-Jones

12.1 Introduction

12.2 Bone architecture and physiology

12.3 Bone growth

12.4 Teeth

12.5 Nutritional rickets

12.6 Bone loss with ageing

12.7 Specific nutrients and their effects on bone health

12.8 Lifestyle factors and bone health

12.9 Perspectives on the future

13 The Immune and Infl ammatory Systems

Parveen Yaqoob and Philip C Calder

13.1 Introduction

13.2 The immune system

13.3 Factors influencing immune function

13.4 Impact of infection on nutrient status

13.5 Why should nutrients affect immune function?

13.6 Assessment of the effect of nutrition on immune function

13.7 Malnutrition and immune function

13.8 The influence of individual micronutrients on immune function

13.9 Dietary fat and immune function

- [**13.10 Dietary amino acids and related compounds and immune function**](#)
- [**13.11 Probiotics and immune function**](#)
- [**13.12 Breast-feeding and immune function**](#)
- [**13.13 Perspectives on the future**](#)

[**14 Phytochemicals**](#)

Aedín Cassidy and Colin D Kay

- [**14.1 Introduction**](#)
- [**14.2 Historical perspective**](#)
- [**14.3 The phenolic phytochemicals**](#)
- [**14.4 Carotenoids**](#)
- [**14.5 Phytosterols**](#)
- [**14.6 Sulphur-containing compounds: sulphides and glucosinolates**](#)
- [**14.7 Phytochemical toxicity**](#)
- [**14.8 Perspectives on the future**](#)

[**15 The Control of Food Intake**](#)

Adam Drewnowski and France Bellisle

- [**15.1 Introduction**](#)
- [**15.2 The underlying structure of eating behaviour**](#)
- [**15.3 Internal controls of food intake**](#)
- [**15.4 The pleasure response to foods**](#)
- [**15.5 The psychology of eating**](#)
- [**15.6 Environmental determinants of food intake**](#)
- [**15.7 Conclusions**](#)

16 Overnutrition

Linda Bandini, Albert Flynn and Renee Scampini

16.1 Introduction

16.2 Identification

16.3 Energy balance

16.4 Factors in the development of obesity

16.5 Consequences of obesity

16.6 Perspectives on the future

16.7 Introduction

16.8 Adverse effects of vitamins and minerals: concepts

16.9 Derivation of the tolerable upper intake level

16.10 Use of tolerable upper intake levels as dietary reference standards

16.11 Perspectives on the future

17 Undernutrition

Paul Kelly

17.1 Introduction

17.2 Definition and classification of undernutrition

17.3 Adaptation and chronic energy deficiency

17.4 Changes in body composition in chronic energy deficiency

17.5 Energy metabolism in chronic energy deficiency

17.6 Regulatory processes in chronic energy deficiency

17.7 Functional consequences of energy deficiency

17.8 Perspectives on the future

18 Exercise Performance

Asker E Jeukendrup and Louise M Burke

18.1 Introduction

18.2 Energy expenditure during physical activity

18.3 Carbohydrate and performance

18.4 Fat metabolism and performance

18.5 Effect of exercise on protein requirements

18.6 Physique and sports performance

18.7 Weight maintenance and other body-weight issues

18.8 Vitamins and minerals

18.9 Fluid and electrolyte loss and replacement in exercise

18.10 Nutritional ergogenics

18.11 Dietary supplements and failed drug tests

18.12 Practical issues in nutrition for athletes

18.13 Perspectives for the future

Index

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Series Foreword

The early decades of the twentieth century were a period of intense research on constituents of food essential for normal growth and development, and saw the discovery of most of the vitamins, minerals, amino acids and essential fatty acids. In 1941, a group of leading physiologists, biochemists and medical scientists recognised that the emerging discipline of nutrition needed its own learned society and the Nutrition Society was established. Our mission was, and remains, 'to advance the scientific study of nutrition and its application to the maintenance of human and animal health'. The Nutrition Society is the largest learned society for nutrition in Europe and we have over 2000 members worldwide. You can find out more about the Society and how to become a member by visiting our website at www.nutsoc.org.uk.

The revolution in biology initiated by large-scale genome mapping and facilitated by the development of reliable, simple-to-use molecular biological tools makes this a very exciting time to be working in nutrition. We now have the opportunity to get a much better understanding of how specific genes interact with nutrient intake and other lifestyle factors to influence gene expression in individual cells and tissues and, ultimately, affect health. Knowledge of the polymorphisms in key genes carried by an individual will allow the prescription of more effective, and safe, dietary treatments. At the population level, molecular epidemiology is opening up much more incisive approaches to understanding the role of particular dietary patterns in disease causation. This excitement is reflected in the several scientific meetings which the Nutrition Society, often in collaboration with sister learned societies in Europe, Africa, Asia and the USA, organise each year. We

provide travel grants and other assistance to encourage students and young researchers to attend and to participate in these meetings.

Throughout its history a primary objective of the Society has been to encourage nutrition research and to disseminate the results of such research. Our first journal, *The Proceedings of the Nutrition Society*, recorded, as it still does, the scientific presentations made to the Society. Shortly afterwards, *The British Journal of Nutrition* was established to provide a medium for the publication of primary research on all aspects of human and animal nutrition by scientists from around the world. Recognising the needs of students and their teachers for authoritative reviews on topical issues in nutrition, the Society began publishing *Nutrition Research Reviews* in 1988. We subsequently launched *Public Health Nutrition*, the first international journal dedicated to this important and growing area. These journals are available in electronic and conventional paper form, and we are exploring new opportunities to exploit the web to make the outcomes of nutritional research more quickly and readily accessible.

Just as in research, having the best possible tools is an enormous advantage in teaching and learning. This is the reasoning behind the initiative to launch this series of human nutrition textbooks designed for use worldwide. The Society is deeply indebted to the founding Editor-in-Chief, Professor Michael J Gibney (University College Dublin), for his fore-sight and hard work in bringing the first editions of this major publishing exercise to successful fruition and for overseeing the production of the second edition of the *Introduction to Nutrition* textbook. We are particularly grateful to Dr Susan A Lanham-New (University of Surrey) for agreeing to take on the challenge of being Editor-in-Chief for the second editions of the other three textbooks (*Nutrition and Metabolism*, *Public Health Nutrition* and

Clinical Nutrition) and for also having the vision to add a fourth textbook, *Sports and Exercise Nutrition*. Read, learn and enjoy.

Ian A Macdonald
President of the Nutrition Society

Preface

More than a decade has passed since the idea of a Nutrition Society Textbook Series was first raised and it has proved to be an enormously successful venture. It is a great honour for me to be the new editor-in-chief of the series and credit should go to the first ever Editor-in-Chief, Professor Michael J Gibney (University College Dublin) for his tremendous vision and hard work in the early days of the Series' development.

Nutrition and Metabolism 2e is the second of this series of four textbooks: *Introduction to Human Nutrition 2e* was published last year and launched at the 2009 Nutrition Society Conference, held at the University of Surrey, Guildford. It was seen very much as an 'introductory' textbook and, as such, was designed not only for students of nutritional sciences but also for the many undergraduate and postgraduate students who have aspects of nutrition in their courses (e.g. medicine, pharmacy, nursing and food science). *Nutrition and Metabolism 2e* is aimed at the student (undergraduate and postgraduate) opting to pursue nutrition as a main academic subject. This textbook, as the title implies, has as its focus the physiological and biochemical basis for the role of nutrients in metabolism. The first seven chapters cover some core areas, some traditional areas, such as the integration of metabolic nutrition or areas related to stages of growth, and also focuses on molecular nutrition. This is an area of considerable growth and development. Following on from this, the chapters are organised in a slightly different manner, taking the view that the role of individual nutrients should be integrated into chapters on a 'systems' level rather than a specific nutrient one.

Plans are well underway for the second edition of *Public Health Nutrition*, and hence this topic is avoided in *Nutrition and Metabolism 2e*. The second edition of *Clinical*

Nutrition Textbook will address the diet-disease links on a system-by-system basis.

The first edition of *Nutrition and Metabolism* was published in 2003 with Professor Ian A Macdonald (University of Nottingham) and Professor Helen M Roche (University College Dublin) as the specific N&M Textbook Editors, doing a splendid job. It has been a great pleasure to have had the opportunity to work with them again on the production of this new edition, and I thank them sincerely for all their hard work.

We have tried to minimise within-textbook overlap and have cross-referenced chapters where possible. However, some level of overlap across texts will undoubtedly occur, but from different perspectives. For example, *Nutrition and Metabolism 2e* introduces an analysis of how nutrients influence risk factors for coronary heart disease with a perspective on the meta-bolic dimension. Much of this will again arise in both *Public Health Nutrition 2e* and *Clinical Nutrition 2e*, from a population and preventive approach and from a patient and therapeutic approach, respectively.

Nutrition and Metabolism 2e is dedicated to Professor Vernon Young, who contributed greatly to the first edition and who sadly died in 2004. We acknowledge the tremendous contribution that he has made to our field of Nutritional Sciences.

There are plans for further titles in the Nutrition Society Textbook Series, which is certainly a fast-moving product, and it is a pleasure for me, as the new Editor-in-Chief, to be driving them.

The Nutrition Society Textbook Series is hugely indebted to Wiley-Blackwell, who have proved to be extremely supportive publishers. Special mention should go to Nigel Balmforth and Laura Price for their commitment to this Series. The Society is also indebted to Jennifer Norton, who is the new assistant editor of the textbooks. Her hard work,

focus and organisation are first rate and we would certainly not be pressing ahead with such pace and efficiency without her input.

I hope that you will find the book of great use. Please enjoy!

*Dr Susan A Lanham-New
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First Edition Acknowledgements

The Nutrition Society would like to express its appreciation and thanks to all our Authors and Editors of the first edition of Nutrition and Metabolism

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To Vernon Young

1

Core Concepts of Nutrition

Ian A Macdonald and Michael J Gibney

Key messages

- The change in body reserves or stores of a nutrient is the difference between the intake of that nutrient and the body's utilisation of that nutrient. The time-frame necessary to assess the body's balance of a particular nutrient varies from one nutrient to another.
- The concept of turnover can be applied at various levels within the body (molecular, cellular, tissue/organs, whole body).
- The flux of a nutrient through a metabolic pathway is a measure of the rate of activity of the pathway. Flux is not necessarily related to the size of the pool or pathway through which the nutrient or metabolite flows.
- Nutrients and metabolites are present in several pools in the body. The size of these metabolic pools varies substantially for different nutrients/metabolites, and a knowledge of how these pools are interconnected greatly helps us to understand nutrition and metabolism.
- Darwinian theory of evolution implies a capacity to adapt to adverse conditions, including adverse dietary conditions. Many such examples can be cited. Some allow for long-term adaptation and others buy time until better conditions arrive.

1.1 Introduction

This textbook on nutrition and metabolism covers macronutrient aspects of nutrition in an integrated fashion. Thus, rather than considering the macronutrients separately, this book brings together information on