

Contents

List of Contributors

xvii

Series Preface

xxv

Preface

xxvii

Part I General and Introductory Aspects 1

1. Reference dietary requirements of vitamins in different stages of life 3

Mina Yamazaki Price and Victor R. Preedy

Key facts of vitamins 4

Summary points 4

Definitions of words and terms 4

Abbreviations 5

1.1 Introduction 5

1.2 Reference dietary requirements 7

1.3 Fat-soluble vitamins 9

1.4 Water-soluble vitamins 15

1.5 Challenges of meeting requirements 29

References 30

Further reading 32

2. Bioactive vitamin-metal compounds: other potential applications of vitamins 33

Paula Brandão and Samuel Guieu

Key facts of vitamin-metal complexes 33

Summary points 34

Abbreviations 34

2.1 Introduction 34

2.2 Vitamin-based metal complexes 35

2.3 Vitamin-based metal-organic frameworks as delivery vehicles of therapeutic molecules 43

2.4 Vitamin-based multinuclear metal compounds with magnetic, luminescent, and electrical properties 44

2.5 Summary 46

Acknowledgments 46

References 46

3. Vitamin E: an overview	51
Farid Khallouki, Robert Wyn Owen, Mourad Akdad, Bachir El Bouhali, Sandrine Silvente-Poirot and Marc Poirot	
Summary points	51
3.1 Chemistry of vitamin E	52
3.2 Biosynthesis of vitamin E	54
3.3 Vitamin E components are phenolic antioxidants	54
3.4 Vitamin E oxidation products	55
3.5 Vitamin E and human pathologies	56
3.6 Vitamin E and disease prevention	57
3.7 Molecular targets for vitamin E	58
3.8 Interference of vitamin E with the pharmacological action of drugs	58
3.9 Conclusion	61
References	61
4. Vitamin E: structure and forms	67
Renata Szymańska, Beatrycze Nowicka, Agnieszka Trela and Jerzy Kruk	
Key facts of vitamin E	67
Definition of words and terms	68
Abbreviations	69
4.1 Introduction	70
4.2 Chemistry, biosynthesis, and occurrence of vitamin E	71
4.3 Rare natural forms of vitamin E	78
4.4 Extraction, separation, and detection methods of vitamin E	79
4.5 Nutritional value of vitamin E	83
References	87
5. Riboflavin-enriched fermented soy milk for redox-mediated gut modulation: in the search of novel prebiotics	91
Kiran Thakur, Zhao-Jun Wei and Sudhir Kumar Tomar	
5.1 Introduction	91
5.2 Riboflavin as an essential vitamin	95
5.3 Riboflavin as a novel prebiotic ingredient?	95
5.4 Redox-mediated gut modulation by vitamin B ₂	97
5.5 Soya as an ideal substrate for lactic acid bacteria fermentation	99
5.6 Conclusion and future outlook	100
References	102

6. A review of vitamin B12	105
Gianluca Rizzo and Antonio Simone Laganà	
Key facts of vitamin B12	105
Summary points	106
Definitions of words and terms	106
Abbreviations	107
6.1 Introduction	108
6.2 Cobalamin content in food	110
6.3 Absorption and transport through the body	112
6.4 Cellular trafficking and metabolism	115
6.5 Cobalamin shortage and deficiency processes	119
6.6 How other vitamins are affected or behave	123
References	124
7. Nutrigenomic aspects of dietary pyridoxine (vitamin B₆) and selenium interaction and their implications in reproduction	131
Danyel Bueno Dalto and Jean-Jacques Matte	
Key facts of transmethylation and transsulfuration in embryos and the impact of vitamin B ₆ to the interplay between them	131
Summary points	132
Abbreviations	132
7.1 Introduction	133
7.2 Pyridoxine sources, recommendations, and bioavailability	134
7.3 Selenium sources, recommendations, and bioavailability	135
7.4 Transmethylation and transsulfuration pathways	137
7.5 Pyridoxine and selenium interaction for the synthesis of selenoproteins	139
7.6 Dietary pyridoxine and selenium on embryo development: studies using a pig model	141
7.7 Conclusions	147
References	147
Further reading	151
8. Vitamin K2 is a key regulator of clinically relevant molecular processes	153
Maria Fusaro, Mario Plebani, Giovanni Tripepi, Giorgio Iervasi, John Cunningham, Francesco Locatelli, Martina Zaninotto, Andrea Aghi, Maria Cristina Mereu and Maurizio Gallieni	
Summary points	153
Abbreviations	154

8.1	Introduction	155
8.2	Metabolism, recycling, and functions of vitamin K	156
8.3	Vitamin K status and vitamin K-dependent proteins	158
8.4	Clinical use of menaquinones	166
8.5	Conclusion	168
	References	168
9.	Biotin status screening	173
	Shin-ichiro Hagiwara	
	Summary points	173
	Definitions of words and terms	174
9.1	Introduction	174
9.2	What is biotin?	175
9.3	Biotin physiology	175
9.4	Causes of biotin deficiency	177
9.5	Symptoms	179
9.6	Biotin status screening	179
	References	180
	Part II Molecular Biology of the Cell	183
10.	Vitamin B₁ and the pyruvate dehydrogenase complex	185
	Yuliya Parkhomenko, Andriy Vovk and Zoya Protasova	
	Key facts of vitamin B ₁	185
	Summary points	186
	Definitions of words and terms	187
	Abbreviations	188
10.1	Biologically active derivatives of vitamin B ₁ in living tissues	189
10.2	Pyruvate dehydrogenase complex	191
10.3	Thiamine, pyruvate dehydrogenase complex, and obesity	194
	References	203
	Further reading	206
11.	Thiamine, oxidative stress, and ethanol	207
	Álisson de Carvalho Gonçalves, Luiz Ricardo Soldi and Guilherme Vannucchi Portari	
	Key facts of oxidative stress	207
	Summary points	208

Definition of words/terms	208
Abbreviations	209
11.1 Introduction	209
11.2 Structure and function of thiamine	210
11.3 Oxidative stress and alcohol metabolism	212
11.4 Thiamine and alcohol metabolism	216
11.5 Alcohol metabolism and other vitamins	218
11.6 Conclusions and perspectives	220
References	220
12. Riboflavin (vitamin B2) and mitochondrial energy	225
Bárbara J. Henriques and Cláudio M. Gomes	
Key facts about riboflavin	225
Key facts about riboflavin-responsive disorders	226
Summary points	227
Definitions of words and terms	227
Abbreviations	229
12.1 Riboflavin and mitochondrial energy	229
12.2 Riboflavin deficiency	231
12.3 Mitochondrial β -oxidation disorders responsive to vitamin B2	233
12.4 Respiratory chain deficiencies	237
12.5 Concluding remarks	239
Acknowledgements	240
References	240
13. Linking homocysteine, B vitamins, and choline to ischemic stroke risk	245
Mahira Moftah, Joshua T. Emmerson and Nafisa M. Jadavji	
Key facts	245
Abbreviations	246
13.1 Introduction	246
13.2 Understanding stroke	247
13.3 Nutrition	248
13.4 Homocysteine and stroke	249
13.5 Clinical trials to reduce levels of homocysteine	251
13.6 Mechanisms explaining folate and homocysteine metabolism as a modulator of stroke outcome	253
13.7 Choline	254
13.8 Future directions	255
References	256

14. Niacin and hyperlipidemia	263
Maria C. Naranjo, Maria C. Millan-Linares and Sergio Montserrat-de la Paz	
Key facts	263
Abbreviations	264
14.1 Introduction	264
14.2 Postprandial hyperlipidemia	265
14.3 Effects of niacin and mechanisms of action	267
14.4 Conclusion	276
Acknowledgments	276
References	276
Further reading	281
15. Novel preventive mechanisms of vitamin B6 against inflammation, inflammasome, and chronic diseases	283
Peipei Zhang, Takashi Suda, Sofya Suidasari, Thanutchaporn Kumrungsee, Noriyuki Yanaka and Norihisa Kato	
Key facts of inflammasome	283
Key facts of carnosine	284
Summary points	284
Definitions of words and terms	285
Abbreviations	285
15.1 Introduction	286
15.2 Conclusions	295
References	296
Further reading	299
16. New properties of vitamin B6 or pyridoxine in experimental oxidative stress in the brain	301
K.E. Danielyan and S.G. Chailyan	
Key facts	301
Abbreviations	302
16.1 Introduction	303
16.2 Description of the free radical-producing systems in the organism	303
16.3 General description of the xanthine oxidase enzyme	304
16.4 Xanthine oxidase regulates purine catabolism by feedback mechanism	305
16.5 Antioxidant systems	308
16.6 Comparison of the influence of pyridoxine ability to trigger cells generation with the nicotinamide, riboflavin, and thiamine	309
16.7 Pyridoxine	310

16.8 The role of pyridoxine in pathological conditions in vitro and in vivo	315
References	319
17. Nonalcoholic fatty liver disease and use of folate	323
O Karmin, Connie W.H. Woo, Victoria Sid and Yaw L. Siow	
Key facts of Fig. 17.1	324
Key facts of Fig. 17.2	324
Key facts of Fig. 17.3	324
Summary points	325
17.1 Introduction	325
17.2 Folate and folic acid	326
17.3 Nonalcoholic fatty liver disease	335
17.4 Conclusions	338
Acknowledgements	339
References	339
18. Folates transport in placentas	345
Erika Castaño-Moreno, Raúl Piñuñuri, Reyna Peñailillo, Paola Casanello, Miguel Llanos and Ana María Ronco	
Key facts of folates and pregnancy	345
Summary points	346
18.1 Introduction	347
18.2 Chemical forms of folates	348
18.3 Requirements of folates during pregnancy	350
18.4 Folate transport in placenta and metabolism	352
18.5 Regulation of folate transport in the placenta	358
References	360
Further reading	365
19. Cobalamin (vitamin B12) malabsorption	367
Emmanuel Andres and Nassim Dali-Youcef	
19.1 Introduction	367
19.2 Cobalamin metabolism and function	369
19.3 Vitamin B12 ingestion and its related disorders	370
19.4 Food-cobalamin digestion and its related disorders	371
19.5 Cobalamin absorption and its related disorders	373
19.6 Cobalamin distribution in the tissues and its related disorders	378
19.7 Particular points of interest for the clinician	379

19.8 Conclusion	381
Acknowledgments	382
References	382
20. γ-Tocotrienol reversal of the Warburg effect in breast cancer cells is associated with 5'-AMP-activated kinase activation	387
Paul William Sylvester and Venkateshwara Dronamraju	
Summary points	387
Definitions of words and terms	388
20.1 γ -Tocotrienol and cancer	389
20.2 Cancer metabolism and aerobic glycolysis	393
20.3 5'-AMP-activated protein kinase structure and function	399
20.4 γ -Tocotrienol effects on 5'-AMP-activated kinase activation and aerobic glycolysis	402
20.5 Conclusion	404
References	405
21. Vitamin D receptor activation and prevention of arterial aging	409
Andrea Stucchi, Ferruccio Conte, Andrea Galassi, Paola Ciceri and Mario Cozzolino	
Key facts	409
Summary points	410
21.1 Background	410
21.2 Vascular calcifications mechanisms	412
21.3 Vitamin D deficiency	413
21.4 Vitamin D receptors	413
21.5 Vitamin D/vitamin D receptor activator physiology	414
21.6 Vitamin D receptor activation and cardiovascular disease	417
21.7 Preclinical studies	417
21.8 Clinical studies	419
21.9 Conclusion	421
References	422
22. Vitamin D in immune regulation and diabetes mellitus	427
Ihor Shymanskyi, Olha Lisakovska, Dmytro Labudzynskyi, Anna Mazanova and Mykola Veliky	
Definition of words and terms	427
22.1 Introduction	428
22.2 Vitamin D synthesis and activation	428

22.3	Role of vitamin D in immune regulation and inflammatory responses	432
22.4	Vitamin D and diabetes mellitus	435
22.5	Conclusions	442
	References	443
23.	Vitamin E: nutritional aspects	447
	Pierangelo Torquato, Rita Marinelli, Desirée Bartolini and Francesco Galli	
	Key facts of vitamin E	447
	Summary points	448
23.1	General concepts and historical steps in vitamin E research	449
23.2	Antioxidant activity	458
23.3	Nutritional aspects	463
23.4	Conclusions	474
	References	474
	Further reading	483
24.	Vitamin E: metabolism and molecular aspects	487
	Pierangelo Torquato, Rita Marinelli, Desirée Bartolini, Danilo Giusepponi, Gabriele Cruciani, Lydia Siragusa, Roberta Galarini, Bartolomeo Sebastiani, Antimo Gioiello and Francesco Galli	
24.1	Introduction	487
24.2	Metabolism	488
24.3	Receptors/sensors, signal transduction and gene modulation effects	494
24.4	Vitamin E metabolites as bioactive molecules	502
24.5	The metabolome of vitamin E: analytical aspects and study perspectives	508
24.6	Conclusion	510
	References	511
25.	Linking vitamin E and nitric oxide in liver disease	519
	Ghazaleh Hajiluian and Farzad Shidfar	
	Key facts	519
	Summary points	520
	Word definition	521
	Abbreviations	521
25.1	Introduction	522
25.2	Liver	523
25.3	Liver diseases	524
25.4	Pathogenesis of liver disease	524
25.5	Liver and nitric oxide	527

25.6	Liver disease and nitric oxide	531
25.7	Liver damage during inflammation	531
25.8	Viral hepatitis infection	532
25.9	Liver cirrhosis	532
25.10	Hepatocellular carcinoma	533
25.11	Ischemia/reperfusion injury and shock	533
25.12	Enzymatic antioxidants	534
25.13	Nonenzymatic antioxidants	534
25.14	Vitamin E	534
25.15	Comparing the activities of other vitamins	538
	References	539
26.	Vitamin E and reproductive health	543
	Siti Syairah Mohd Mutalip	
	Key facts	543
	Summary points	544
	Definitions of words and terms	544
	Abbreviations	545
26.1	Introduction	545
26.2	Vitamin E	545
26.3	Reproduction	547
26.4	Conclusion	555
	References	555
27.	Vitamins in chronic kidney disease	561
	Magdalena Jankowska	
	Abbreviations	562
27.1	Introduction	562
27.2	Contributors to altered vitamin status in chronic kidney disease	565
27.3	Water-soluble vitamins	570
27.4	Fat-soluble vitamins	573
27.5	Recommendations on supplementation	576
27.6	Conclusions	576
	References	578
28.	Inflammatory bowel disorders and fat-soluble vitamins	583
	Mikołaj Świerczyński, Jakub Fichna and Agata Szymaszkiewicz	
	Key facts of inflammatory bowel diseases	583
	Key facts of fat-soluble vitamins	584

Summary points	584
Abbreviations	585
28.1 Inflammatory bowel disease	585
28.2 Nutritional state and malnutrition in inflammatory bowel disease	586
28.3 Fat-soluble vitamins: structures, roles, sources	590
28.4 Vitamin A	592
28.5 Vitamin A and inflammatory bowel disease	594
28.6 Vitamin E	595
28.7 Vitamin E and inflammatory bowel disease	596
28.8 Vitamin K	597
28.9 Vitamin K and inflammatory bowel disease	598
28.10 Vitamin D	598
28.11 Vitamin D and inflammatory bowel disease	599
28.12 Vitamin D supplementation	604
28.13 Diet in inflammatory bowel disease	605
Acknowledgments	607
References	607
29. Prostate cancer and applications of vitamin K	613
Smita Vinjamuri, Venkata Satish Dontaraju and Gnanasekar Munirathinam	
Key facts	613
Summary points	614
Abbreviations	614
29.1 Introduction	614
29.2 Conclusion	625
References	626
Part III Genetic Machinery and its Function	631
30. Vitamins and epigenetics	633
Simonetta Friso, Domenica De Santis, Francesca Pizzolo and Silvia Udali	
Key facts of vitamins and epigenetics	633
Summary points	634
Definitions of words and terms	634
30.1 Introduction	635
30.2 Vitamins and epigenetic mechanisms	639
30.3 Conclusions	646
References	647

31. Transcriptional control of cells by vitamin D and its role in liver health and disease	651
Daniel Jahn and Andreas Geier	
Summary points	651
Definition of words and term	652
List of abbreviations	652
31.1 Vitamin D metabolism	653
31.2 The nuclear vitamin D receptor	657
31.3 The role of vitamin D and vitamin D receptor in liver health and disease	661
References	667
32. Vitamin B3: niacin and transcriptome analysis in relation to the GPR109A receptor	673
Allison Bridges, Pragya Rajpurohit, Puttur D. Prasad and Muthusamy Thangaraju	
Key facts of GPR109A and tumor suppression	673
Summary points	674
Abbreviations	674
32.1 Introduction	675
32.2 GPR109A: a receptor for niacin	675
32.3 The role of GPR109A in tissue	679
32.4 Future perspective/clinical relevance	685
References	686
33. Vitamin C: epigenetic roles and cancer	691
Sushmita Mustafi and Gaofeng Wang	
Key facts of vitamin C and cancer	691
Summary points	692
Definitions of words and terms	692
33.1 Vitamin C intake and cancer	694
33.2 The epigenetic role of vitamin C in cancer treatment	697
33.3 Other potential mechanisms in the anticancer action of vitamin C	703
33.4 Summary	705
Acknowledgments	705
References	705
<i>Author Index</i>	<i>711</i>
<i>Subject Index</i>	<i>735</i>