

Contents

1 Biotin	1	Safety	14
Function	1	Toxicity.....	14
Enzyme Cofactor.....	1	Drug Interactions	14
Histone Biotinylation	1	3 Niacin	17
Deficiency	1	Function	17
Signs and Symptoms.....	1	Oxidation–Reduction	
Predisposing Conditions.....	2	(Redox) Reactions	17
Adequate Intake.....	2	Non-redox Reactions	17
Disease Prevention	3	Deficiency	18
Birth Defects.....	3	Pellagra.....	18
Disease Treatment	3	Nutrient Interactions	19
Diabetes Mellitus.....	3	Recommended Dietary Allowance	19
Brittle Fingernails.....	3	Disease Prevention	19
Hair Loss.....	4	Cancer.....	19
Sources	4	Type 1 Diabetes Mellitus	20
Food Sources.....	4	Disease Treatment	21
Bacterial Synthesis	4	High Cholesterol and	
Safety	4	Cardiovascular Disease	21
Toxicity.....	4	Human Immunodeficiency Virus.....	21
Nutrient Interactions.....	4	Sources	22
Drug Interactions.....	5	Food Sources.....	22
2 Folic Acid	7	Supplements.....	22
Function	7	Safety	22
One-carbon Metabolism.....	7	Toxicity.....	22
Nutrient Interactions.....	8	Drug Interactions	23
Deficiency	8	4 Pantothenic Acid	26
Causes.....	8	Function	26
Symptoms.....	9	Coenzyme A.....	26
Recommended Dietary Allowance	9	Acyl-carrier Protein.....	26
Dietary Folate Equivalents.....	9	Deficiency	26
Genetic Variation		Adequate Intake.....	27
in Folate Requirements	10	Disease Prevention	27
Disease Prevention	10	Disease Treatment	27
Pregnancy Complications.....	10	Wound Healing	27
Cardiovascular Diseases	11	High Cholesterol	27
Cancer	12	Sources	28
Alzheimer Disease		Food Sources.....	28
and Cognitive Impairment	13	Intestinal Bacteria	28
Disease Treatment	13	Supplements.....	28
Sources	14	Safety	28
Food Sources	14	Toxicity.....	28
Supplements.....	14	Drug Interactions	29

5	Riboflavin	30	Disease Treatment	46
	Function	30	Pharmacological Doses of Retinoids	46
	Oxidation–Reduction (Redox) Reactions	30	Diseases of the Skin	46
	Antioxidant Functions	30	Sources	46
	Nutrient Interactions	31	Retinol Activity Equivalents	46
	Deficiency	31	Food Sources	47
	Risk Factors for Riboflavin Deficiency	32	Supplements	48
	Recommended Dietary Allowance	32	Safety	48
	Disease Prevention	33	Toxicity	48
	Cataracts	33	Safety in Pregnancy	48
	Disease Treatment	33	Effects on Bone	49
	Migraine Headaches	33	Drug Interactions	49
	Sources	34	8 Vitamin B₆	52
	Food Sources	34	Function	52
	Supplements	34	Nervous System Function	52
	Safety	34	Red Blood Cell Formation and Function	52
	Toxicity	34	Niacin Formation	52
	Drug Interactions	34	Hormone Function	52
6	Thiamin	36	Nucleic Acid Synthesis	52
	Function	36	Deficiency	52
	Coenzyme Function	36	Recommended Dietary Allowance	53
	Deficiency	36	Disease Prevention	53
	Causes of Thiamin Deficiency	37	Cardiovascular Diseases	53
	Recommended Dietary Allowance	37	Immune Function	54
	Disease Prevention	38	Cognitive Function	54
	Cataracts	38	Kidney Stones	55
	Disease Treatment	38	Disease Treatment	55
	Alzheimer Disease	38	Side Effects of Oral Contraceptives	55
	Congestive Heart Failure	38	Premenstrual Syndrome	55
	Cancer	39	Depression	56
	Sources	39	Nausea and Vomiting in Pregnancy	56
	Food Sources	39	Carpal Tunnel Syndrome	56
	Supplements	39	Sources	56
	Safety	39	Food Sources	56
	Toxicity	39	Supplements	56
	Drug Interactions	40	Safety	57
7	Vitamin A	42	Toxicity	57
	Function	42	Drug Interactions	57
	Vision	42	9 Vitamin B₁₂	60
	Regulation of Gene Expression	43	Function	60
	Immunity	44	Cofactor for Methionine Synthase	60
	Growth and Development	44	Cofactor for Methylmalonyl-CoA	
	Red Blood Cell Production	44	Mutase	60
	Nutrient Interactions	44	Deficiency	60
	Deficiency	44	Causes of Vitamin B ₁₂ Deficiency	60
	Vitamin A Deficiency and Vision	44	Other Causes of Vitamin B ₁₂ Deficiency	62
	Vitamin A Deficiency and Infectious		Symptoms of Vitamin B ₁₂ Deficiency	62
	Disease	44	Recommended Dietary Allowance	63
	Recommended Dietary Allowance	45	Disease Prevention	64
	Disease Prevention	45	Cardiovascular Diseases	64
	Cancer	45	Cancer	64

Neural Tube Defects.....	65	Disease Prevention	87
Alzheimer Disease and Dementia.....	65	Osteoporosis.....	87
Depression	66	Cancer.....	88
Sources	66	Autoimmune Diseases.....	89
Food Sources.....	66	Hypertension	90
Supplements.....	67	Sources	90
Safety	67	Sunlight.....	90
Toxicity.....	67	Food Sources.....	91
Drug Interactions	67	Supplements.....	91
10 Vitamin C	70	Safety	91
Function	70	Toxicity.....	91
Deficiency	70	Drug Interactions	92
Scurvy.....	70	12 Vitamin E	96
Recommended Dietary Allowance	70	Function	96
Disease Prevention	70	α -Tocopherol.....	96
Cardiovascular Diseases	71	γ -Tocopherol.....	96
Cancer.....	72	Deficiency	97
Cataracts.....	73	Recommended Dietary Allowance	97
Gout.....	73	Disease Prevention	98
Lead Toxicity	73	Cardiovascular Diseases	98
Role in Immunity.....	74	Cataracts	98
Disease Treatment	74	Immune Function.....	99
Cardiovascular Diseases	74	Cancer	99
Cancer.....	75	Disease Treatment	99
Diabetes Mellitus.....	75	Cardiovascular Diseases	99
Common Cold.....	76	Diabetes Mellitus.....	100
Sources	76	Dementia (Impaired Cognitive	
Food Sources.....	76	Function)	100
Supplements.....	76	Cancer.....	101
Safety	77	Sources	101
Toxicity.....	77	Food Sources.....	101
Does Vitamin C Promote Oxidative		Supplements	102
Damage under Physiological		Safety	102
Conditions?	78	Toxicity.....	102
Kidney Stones	78	Vitamin E Supplementation and	
Drug Interactions	78	All-cause Mortality	103
11 Vitamin D	83	Drug Interactions	103
Function	83	13 Vitamin K	107
Activation of Vitamin D.....	83	Function	107
Mechanisms of Action.....	83	Coagulation	107
Calcium Balance.....	83	Bone Mineralization	108
Cell Differentiation	83	Cell Growth	108
Immunity	84	Deficiency	109
Insulin Secretion.....	84	Controversy Surrounding Vitamin K	
Blood Pressure Regulation.....	84	Administration and Newborn Infants	109
Deficiency	85	Adequate Intake	109
Severe Vitamin D Deficiency	85	Disease Prevention	110
Risk Factors for Vitamin D Deficiency	85	Osteoporosis.....	110
Assessing Vitamin D Nutritional Status ...	86	Vascular Calcification and	
Recommended Dietary Allowance	86	Cardiovascular Disease.....	111

Sources	112	Sources	132
Food Sources.....	112	Food Sources.....	132
Intestinal Bacteria	112	Supplements.....	132
Safety	112	Safety	132
Toxicity.....	112	Toxicity.....	132
Nutrient Interactions.....	112	Drug Interactions	133
Drug Interactions	113		
14 Calcium	115	16 Copper	135
Function	115	Function	135
Structure.....	115	Energy Production.....	135
Cell Signaling.....	115	Connective Tissue Formation	135
Cofactor for Enzymes and Proteins.....	115	Iron Metabolism.....	135
Regulation of Calcium Levels.....	115	Central Nervous System	135
Deficiency	116	Melanin Formation	135
Nutrient Interactions.....	116	Antioxidant Functions	135
Recommended Dietary Allowance	117	Regulation of Gene Expression	136
Disease Prevention	118	Nutrient Interactions.....	136
Colorectal Cancer	118	Deficiency	136
Osteoporosis.....	118	Individuals at Risk of Deficiency	137
Kidney Stones	119	Recommended Dietary Allowance	137
Pregnancy-induced Hypertension	120	Disease Prevention	137
Lead Toxicity	120	Cardiovascular Diseases	137
Disease Treatment	121	Immune System Function	138
Hypertension	121	Osteoporosis.....	139
Premenstrual Syndrome	121	Sources	139
Sources	122	Food Sources.....	139
Food Sources	122	Supplements.....	139
Supplements.....	122	Safety	139
Lead in Calcium Supplements	123	Toxicity.....	139
Safety	123	Drug Interactions	140
Toxicity.....	123		
Do High Calcium Intakes Increase the Risk of Prostate Cancer?	124	17 Fluoride (Fluorine)	142
Drug Interactions.....	124	Function	142
Nutrient Interactions.....	125	Nutrient Interactions.....	142
Recent Research	125	Deficiency	142
Calcium and Weight Loss	125	Adequate Intake	142
		Disease Prevention	143
15 Chromium	128	Dental Caries	143
Function	128	Osteoporosis.....	143
Nutrient Interactions.....	128	Disease Treatment	144
Deficiency	129	Osteoporosis.....	144
Adequate Intake.....	129	Sources	145
Disease Prevention	130	Water Fluoridation	145
Impaired Glucose Tolerance and Type 2 Diabetes Mellitus	130	Food and Beverage Sources.....	145
Cardiovascular Diseases	130	Supplements	145
Health Claims.....	130	Toothpaste.....	146
Disease Treatment	131	Safety	146
Type 2 Diabetes Mellitus	131	Adverse Effects.....	146
Gestational Diabetes.....	131	Drug Interactions	147

18 Iodine	149	Inhibitors of Nonheme Iron	
Function	149	Absorption	163
Deficiency	149	Typical Dietary Intake	163
The Effects of Iodine Deficiency by		Supplements	163
Developmental Stage	150	Iron Overload	164
Nutrient Interactions	151	Hereditary Hemochromatosis	164
Goitrogens	151	Hereditary Anemias	164
Individuals at Risk of Iodine Deficiency ..	152	Safety	164
Recommended Dietary Allowance	152	Toxicity	164
Disease Prevention	152	Diseases Associated with Iron Excess	165
Radiation-induced Thyroid Cancer	152	Drug Interactions	166
Disease Treatment	152	20 Magnesium	169
Fibrocystic Breast Condition	152	Function	169
Sources	153	Energy Production	169
Food Sources	153	Synthesis of Essential Biomolecules	169
Supplements	153	Structural Roles	169
Safety	153	Ion Transport across Cell Membranes	169
Acute Toxicity	153	Cell Signaling	169
Iodine Excess	154	Cell Migration	169
Drug Interactions	154	Nutrient Interactions	169
19 Iron	157	Deficiency	170
Function	157	Recommended Dietary Allowance	170
Oxygen Transport and Storage	157	Disease Prevention	170
Electron Transport and Energy		Hypertension	170
Metabolism	157	Cardiovascular Diseases	171
Antioxidant and Beneficial Prooxidant		Osteoporosis	171
Functions	157	Disease Treatment	172
Oxygen Sensing	157	Hypertension	172
DNA Synthesis	158	Pre-eclampsia–Eclampsia	172
Regulation of Intracellular Iron	158	Cardiovascular Diseases	173
Systemic Regulation of Iron		Diabetes Mellitus	173
Homeostasis	158	Migraine Headaches	174
Nutrient Interactions	158	Asthma	174
Deficiency	159	Sources	174
Symptoms of Iron Deficiency	159	Food Sources	174
Individuals at Increased Risk of Iron		Supplements	175
Deficiency	159	Safety	175
Recommended Dietary Allowance	160	Toxicity	175
Disease Prevention	161	Drug Interactions	176
Impaired Intellectual Development		21 Manganese	179
in Children	161	Function	179
Lead Toxicity	161	Antioxidant Function	179
Pregnancy Complications	161	Metabolism	179
Impaired Immune Function	161	Bone Development	179
Disease Treatment	162	Wound Healing	179
Restless Legs Syndrome	162	Nutrient Interactions	179
Sources	162	Deficiency	180
Food Sources	162	Adequate Intake	180
Enhancers of Nonheme Iron			
Absorption	162		

Disease Prevention	180	Disease Prevention	197
Osteoporosis	181	Stroke	197
Diabetes Mellitus	181	Osteoporosis	198
Seizure Disorders	181	Kidney Stones	198
Sources	181	Disease Treatment	199
Food Sources	181	Hypertension	199
Breast Milk and Infant Formulas	182	Sources	199
Water	182	Food Sources	199
Supplements	182	Supplements	200
Safety	182	Safety	200
Toxicity	182	Toxicity (Excess)	200
Individuals with Increased		Adverse Reactions to Potassium	
Susceptibility to Manganese Toxicity	183	Supplements	200
Drug Interactions	184	Drug Interactions	201
High Levels of Manganese in Supple-			
ments Marketed for Bone/Joint		25 Selenium	203
Health	184	Function	203
22 Molybdenum	187	Selenoproteins	203
Function	187	Nutrient Interactions	204
Nutrient Interactions	187	Deficiency	205
Deficiency	187	Individuals at Increased Risk of	
Recommended Dietary Allowance	188	Selenium Deficiency	205
Disease Prevention	188	Keshan Disease	205
Gastroesophageal Cancer	188	Kashin-Beck Disease	205
Sources	189	Recommended Dietary Allowance	205
Food Sources	189	Disease Prevention	206
Supplements	189	Immune Function	206
Safety	189	Viral Infection	206
Toxicity	189	Cancer	206
Drug Interactions	189	Cardiovascular Diseases	208
23 Phosphorus	191	Type 2 Diabetes Mellitus	209
Function	191	Disease Treatment	209
Nutrient Interactions	191	HIV/AIDS	209
Deficiency	192	Sources	209
Recommended Dietary Allowance	193	Food Sources	209
Sources	193	Supplements	210
Food Sources	193	Selenium-enriched Vegetables	210
Supplements	193	Safety	210
Safety	193	Toxicity	210
Toxicity	193	Drug Interactions	211
Drug Interactions	194		
24 Potassium	196	26 Sodium Chloride	214
Function	196	Function	214
Maintenance of Membrane Potential	196	Maintenance of Membrane Potential	214
Cofactor for Enzymes	196	Nutrient Absorption and Transport	215
Deficiency	197	Maintenance of Blood Volume and	
Conditions that Increase the Risk of		Blood Pressure	215
Hypokalemia	197	Deficiency	215
Adequate Intake	197	Hyponatremia	215
		Adequate Intake for Sodium	216

Disease Prevention (Dietary Sodium and Disease)	216	Impaired Immune Response in Elderly People.....	227
Gastric Cancer	216	Pregnancy Complications	227
Osteoporosis	216	Disease Treatment	228
Kidney Stones	217	Common Cold.....	228
Hypertension	217	Age-related Macular Degeneration	229
Cardiovascular Diseases	219	Diabetes Mellitus	229
Sources	219	HIV/AIDS	229
Safety	219	Sources	229
Toxicity.....	219	Food Sources.....	229
Adverse Effects.....	220	Supplements	230
Drug Interactions	221	Safety	230
27 Zinc	224	Toxicity.....	230
Function	224	Drug Interactions	230
Catalytic Role	224	Appendix	235
Structural Role	224	Nutrient–Nutrient Interactions	236
Regulatory Role.....	224	Drug–Nutrient Interactions	239
Nutrient Interactions.....	224	Quick Reference to Diseases	243
Deficiency	225	Glossary	248
Severe Zinc Deficiency	225	The Linus Pauling Institute	
Mild Zinc Deficiency	225	Prescription for Health	270
Recommended Dietary Allowance	226	Healthy Eating.....	270
Disease Prevention	226	Healthy Lifestyle.....	270
Impaired Growth and Development.....	226	Supplements.....	270
Increased Susceptibility to Infectious Disease in Children.....	227	Index	273