

Contents

1 Biotin	1	Safety	14
Function	1	Toxicity.....	14
Enzyme Cofactor.....	1	Drug Interactions	14
Histone Biotinylation	1		
Deficiency	1	3 Niacin	17
Signs and Symptoms.....	1	Function	17
Predisposing Conditions.....	2	Oxidation–Reduction	
Adequate Intake.....	2	(Redox) Reactions	17
Disease Prevention	3	Non-redox Reactions	17
Birth Defects	3	Deficiency	18
Disease Treatment	3	Pellagra	18
Diabetes Mellitus.....	3	Nutrient Interactions	19
Brittle Fingernails	3	Recommended Dietary Allowance	19
Hair Loss.....	4	Disease Prevention	19
Sources	4	Cancer.....	19
Food Sources.....	4	Type 1 Diabetes Mellitus	20
Bacterial Synthesis	4	Disease Treatment	21
Safety	4	High Cholesterol and	
Toxicity.....	4	Cardiovascular Disease	21
Nutrient Interactions.....	4	Human Immunodeficiency Virus.....	21
Drug Interactions	5	Sources	22
		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		
Causes.....	8	4 Pantothenic Acid	26
Symptoms	9	Function	26
Recommended Dietary Allowance	9	Coenzyme A.....	26
Dietary Folate Equivalents.....	9	Acyl-carrier Protein.....	26
Genetic Variation		Deficiency	26
in Folate Requirements	10	Adequate Intake.....	27
Disease Prevention	10	Disease Prevention	27
Pregnancy Complications.....	10	Disease Treatment	27
Cardiovascular Diseases	11	Wound Healing	27
Cancer	12	High Cholesterol	27
Alzheimer Disease		Sources	28
and Cognitive Impairment	13	Food Sources.....	28
Disease Treatment	13	Intestinal Bacteria	28
Sources	14	Supplements.....	28
Food Sources	14	Safety	28
Supplements.....	14	Toxicity.....	28
		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
				Dental Caries	143
				Osteoporosis.....	143
15	Chromium	128		Disease Treatment	144
	Function	128		Osteoporosis.....	144
	Nutrient Interactions.....	128		Sources	145
	Deficiency	129		Water Fluoridation	145
	Adequate Intake.....	129		Food and Beverage Sources.....	145
	Disease Prevention	130		Supplements	145
	Impaired Glucose Tolerance and Type 2 Diabetes Mellitus	130		Toothpaste.....	146
	Cardiovascular Diseases	130		Safety	146
	Health Claims.....	130		Adverse Effects.....	146
	Disease Treatment	131		Drug Interactions	147
	Type 2 Diabetes Mellitus	131			
	Gestational Diabetes	131			

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				
	Health	184			
22	Molybdenum	187	25	Selenium	203
	Function	187		Function	203
	Nutrient Interactions	187		Selenoproteins	203
	Deficiency	187		Nutrient Interactions	204
	Recommended Dietary Allowance	188		Deficiency	205
	Disease Prevention	188		Individuals at Increased Risk of	
	Gastroesophageal Cancer	188		Selenium Deficiency	205
	Sources	189		Keshan Disease	205
	Food Sources	189		Kashin–Beck Disease	205
	Supplements	189		Recommended Dietary Allowance	205
	Safety	189		Disease Prevention	206
	Toxicity	189		Immune Function	206
	Drug Interactions	189		Viral Infection	206
				Cancer	206
				Cardiovascular Diseases	208
				Type 2 Diabetes Mellitus	209
23	Phosphorus	191		Disease Treatment	209
	Function	191		HIV/AIDS	209
	Nutrient Interactions	191		Sources	209
	Deficiency	192		Food Sources	209
	Recommended Dietary Allowance	193		Supplements	210
	Sources	193		Selenium-enriched Vegetables	210
	Food Sources	193		Safety	210
	Supplements	193		Toxicity	210
	Safety	193		Drug Interactions	211
	Toxicity	193			
	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
Gastric Cancer.....	216
Osteoporosis.....	216
Kidney Stones.....	217
Hypertension.....	217
Cardiovascular Diseases.....	219
Sources	219
Safety	219
Toxicity.....	219
Adverse Effects.....	220
Drug Interactions.....	221
27 Zinc	224
Function	224
Catalytic Role.....	224
Structural Role.....	224
Regulatory Role.....	224
Nutrient Interactions.....	224
Deficiency	225
Severe Zinc Deficiency.....	225
Mild Zinc Deficiency.....	225
Recommended Dietary Allowance.....	226
Disease Prevention	226
Impaired Growth and Development.....	226
Increased Susceptibility to Infectious Disease in Children.....	227
Impaired Immune Response in Elderly People.....	227
Pregnancy Complications.....	227
Disease Treatment	228
Common Cold.....	228
Age-related Macular Degeneration.....	229
Diabetes Mellitus.....	229
HIV/AIDS.....	229
Sources	229
Food Sources.....	229
Supplements.....	230
Safety	230
Toxicity.....	230
Drug Interactions.....	230
Appendix	235
Nutrient–Nutrient Interactions	236
Drug–Nutrient Interactions	239
Quick Reference to Diseases	243
Glossary	248
The Linus Pauling Institute	
Prescription for Health	270
Healthy Eating.....	270
Healthy Lifestyle.....	270
Supplements.....	270
Index	273