

TABLE OF CONTENTS

Chapter 1	
The Biosphere	1
Chapter 2	
The Anthroposphere	3
I. Introduction	3
II. Air Pollution	4
III. Water Pollution	6
IV. Soil	10
A. Soil Contamination	10
B. Soil Reclamation	18
V. Plants	18
Chapter 3	
Soils and Soil Processes	23
I. Introduction	23
II. Weathering Processes	23
III. Pedogenic Processes	28
A. Dissolution and Mobilization	32
B. Transport and Budget	36
C. Sorption and Adsorption	39
D. Speciation	41
Chapter 4	
Soil Constituents	45
I. Introduction	45
II. Minerals	45
A. Clay Minerals and Other Aluminosilicates	46
B. Oxides and Hydroxides	48
C. Carbonates	49
D. Phosphates	49
E. Sulfides, Sulfates, and Chlorides	51
III. Organisms in Soils	52
A. Microorganisms	52
B. Invertebrates	58
IV. Organic Matter	58
Chapter 5	
Trace Elements in Plants	67
I. Introduction	67
II. Absorption	67
A. Root Uptake	68
B. Foliar Uptake	69
III. Translocation	70
IV. Availability	71
V. Essentiality, Deficiency, and Excess	73
VI. Toxicity and Tolerance	78
VII. Interaction	85

Chapter 6

Elements of Group I	89
I. Introduction	89
II. Lithium	89
A. Soils	89
B. Plants	89
III. Rubidium	92
A. Soils	92
B. Plants	92
IV. Cesium	94
A. Soils	94
B. Plants	94
C. ¹³⁷ Cesium	94
V. Copper	95
A. Soils	95
1. Reactions with Soil Components	97
2. Contamination of Soils	100
B. Plants	101
1. Absorption and Transport	101
2. Biochemical Functions	103
3. Interactions with Other Elements	104
4. Concentrations in Plants	105
VI. Silver	108
A. Soils	108
B. Plants	109
VII. Gold	110
A. Soils	110
B. Plants	110

Chapter 7

Elements of Group II	113
I. Introduction	113
II. Beryllium	113
A. Soils	113
B. Plants	115
III. Strontium	115
A. Soils	115
B. Plants	116
IV. Barium	118
A. Soils	118
B. Plants	118
V. Radium	120
VI. Zinc	120
A. Soils	120
1. Reactions with Soil Components	121
2. Contamination of Soils	125
B. Plants	125
1. Absorption and Transport	125
2. Biochemical Functions	128
3. Interactions with Other Elements	129
4. Concentrations in Plants	130

VII.	Cadmium	131
	A. Soils	131
	B. Plants	136
	1. Absorption and Transport	136
	2. Biochemical Roles	139
	3. Interactions with Other Elements	140
	4. Concentrations in Plants	141
VIII.	Mercury	142
	A. Soils	142
	B. Plants	147
	1. Biochemical Roles	147
	2. Concentrations in Plants	149

Chapter 8

	Elements of Group III	153
I.	Introduction	153
II.	Boron	153
	A. Soils	153
	B. Plants	155
	1. Absorption and Transport	155
	2. Biochemical Functions	157
	3. Interactions with Other Elements	158
	4. Concentrations in Plants	159
III.	Aluminum	161
	A. Soils	161
	B. Plants	161
IV.	Gallium	163
	A. Soils	163
	B. Plants	163
V.	Indium	164
	A. Soils	164
	B. Plants	164
VI.	Thallium	165
	A. Soils	165
	B. Plants	165
VII.	Scandium	166
	A. Soils	166
	B. Plants	167
VIII.	Yttrium	168
	A. Soils	168
	B. Plants	168
IX.	Lanthanides	169
	A. Soils	169
	B. Plants	170
X.	Actinides	178
	A. Soils	178
	B. Plants	181

Chapter 9

	Elements of Group IV	183
I.	Introduction	183

II.	Silicon	183
	A. Soils.....	183
	B. Plants.....	183
III.	Germanium	185
	A. Soils.....	185
	B. Plants.....	185
IV.	Tin.....	186
	A. Soils.....	186
	B. Plants.....	186
V.	Lead	187
	A. Soils.....	187
	1. Reactions with Soil Components.....	187
	2. Contamination of Soils.....	189
	B. Plants.....	191
	1. Absorption and Transport.....	192
	2. Biochemical Roles	194
	3. Interactions with Other Elements	195
	4. Concentrations in Plants	196
VI.	Titanium	198
	A. Soils.....	198
	B. Plants.....	200
VII.	Zirconium.....	200
	A. Soils.....	200
	B. Plants.....	201
VIII.	Hafnium	201

Chapter 10

Elements of Group V	203	
I. Introduction.....	203	
II. Arsenic	203	
	A. Soils.....	203
	B. Plants.....	207
III. Antimony	209	
	A. Soils.....	209
	B. Plants.....	210
IV. Bismuth.....	210	
V. Vanadium.....	211	
	A. Soils.....	211
	B. Plants.....	212
VI. Niobium	215	
VII. Tantalum.....	216	

Chapter 11

Elements of Group VI	217	
I. Introduction.....	217	
II. Selenium.....	217	
	A. Soils.....	217
	B. Plants.....	221
III. Tellurium	225	
IV. Polonium	226	
V. Chromium	227	
	A. Soils.....	227

B.	Plants.....	229
VI.	Molybdenum.....	233
A.	Soils.....	233
B.	Plants.....	237
1.	Absorption and Biochemical Functions	237
2.	Interactions with Other Elements	238
3.	Concentrations in Plants	238
VII.	Tungsten.....	240

Chapter 12

	Elements of Group VII	243
I.	Introduction.....	243
II.	Fluorine.....	243
A.	Soils.....	243
B.	Plants.....	247
1.	Absorption and Transport	247
2.	Biochemical Roles	247
3.	Concentrations in Plants	249
III.	Chlorine	251
A.	Soils.....	251
B.	Plants.....	251
IV.	Bromine	252
A.	Soils.....	252
B.	Plants.....	253
V.	Iodine.....	254
A.	Soils.....	254
B.	Plants.....	257
VI.	Manganese.....	258
A.	Soils.....	258
B.	Plants.....	262
1.	Absorption and Transport	262
2.	Biochemical Functions	264
3.	Interactions with Other Elements	266
4.	Concentrations in Plants	267
VII.	Rhenium.....	267

Chapter 13

	Elements of Group VIII	271
I.	Introduction.....	271
II.	Iron.....	271
A.	Soils.....	271
B.	Plants.....	274
1.	Absorption and Transport	274
2.	Biochemical Functions	274
3.	Interactions with Other Elements	276
4.	Concentrations in Plants	276
III.	Cobalt.....	276
A.	Soils.....	276
B.	Plants.....	280
1.	Absorption and Transport	280

	2.	Biochemical Functions	280
	3.	Interactions with Other Elements	284
	4.	Concentrations in Plants	284
IV.	Nickel.....		285
	A.	Soils.....	285
	B.	Plants.....	288
		1. Absorption and Biochemical Functions	288
		2. Interactions with Other Elements	291
		3. Concentrations in Plants	291
V.	Platinum-Group Metals		293
	A.	Ruthenium.....	294
	B.	Rhodium	295
	C.	Palladium.....	295
	D.	Osmium	295
	E.	Iridium	295
	F.	Platinum.....	296
	Appendix		297
	References.....		301
	Index		343