

# Inhaltsverzeichnis — Contents.

## Special Methods of Isolation and Purification

<b>Enzymes du Métabolisme du Soufre.</b> Par F. CHAPEVILLE et P. FROMAGEOT. Avec 1 Figure	1
A. Enzymes d'activation et de transfert du sulfate . . . . .	1
I. Enzymes d'activation du sulfate. . . . .	3
1. Mesure de l'activité enzymatique . . . . .	3
a) Système complet d'activation . . . . .	3
b) ATP-sulfurylase — ROBBINS et LIPMANN (1958a) . . . . .	3
c) ADP-sulfurylase — ROBBINS et LIPMANN (1958a) . . . . .	4
d) APS-kinase — ROBBINS et LIPMANN (1958a). . . . .	4
2. Préparation de l'ATP-sulfurylase, de l'ADP-sulfurylase et de l'APS-kinase	4
II. Enzymes de transfert du sulfate. . . . .	6
1. Mesure de l'activité: de la phénol-sulfokinase . . . . .	6
2. Préparation de la phénol-sulfokinase — GREGORY et LIPMANN (1957) . . . . .	7
B. Systèmes réducteurs du sulfate. . . . .	8
1. Mesure de l'activité sulfato-réductrice . . . . .	8
2. Préparation du système réducteur du sulfate, HILZ, KITTLER et KNAPE (1959). . . . .	9
C. Sulfatases . . . . .	10
1. Arylsulfatases . . . . .	11
Préparation des arylsulfatases . . . . .	11
2. Chondrosulfatases. . . . .	12
3. Myrosulfatases . . . . .	12
4. Glucosulfatases . . . . .	12
5. Stéroïdesulfatases. . . . .	12
6. Cholinesulfatase . . . . .	12
D. Enzymes du métabolisme du thiosulfate, du sulfite et du sulfure . . . . .	13
I. Enzymes du métabolisme du thiosulfate . . . . .	13
1. Thiosulfate-réductase . . . . .	13
2. Rhodanbse . . . . .	14
II. Enzymes du métabolisme du sulfite . . . . .	14
1. Formation du sulfite par désulfination. . . . .	14
2. Sulfite-réductase . . . . .	15
3. Sulfite-oxydase . . . . .	16
III. Enzymes du métabolisme du sulfure . . . . .	16
1. Formation d'hydrogène sulfuré à partir de la cystéine . . . . .	16
2. Sérine-sulphydrase . . . . .	18
3. Oxydation du sulfure . . . . .	19
Bibliographic . . . . .	19
<b>Enzymes of Phosphate Metabolism.</b> By P. S. KRISHNAN. . . . .	20
I. Special Features of Enzyme Isolation and Purification . . . . .	20
1. Choice of Starting Material. . . . .	20
2. Conventional versus Modern Methods of Enzyme Purification. . . . .	20
a) Automatic Device for Ammonium Sulfate Addition. . . . .	22
b) Dialysis of Enzyme Solutions . . . . .	22
3. Stability of Enzymes on Dilution . . . . .	22
II. Assay of Phosphatase Activity . . . . .	22
1. Colorimetric Estimation of Phosphorus . . . . .	23
2. Aspects of Enzyme Assay in Plants and Microorganisms . . . . .	25
III. Intracellular Localization of Enzymes by the Technique of Differential Centrifugation . . . . .	29
1. Nuclear Fraction . . . . .	32

2. Plastid Fraction . . . . .	32
3. Mitochondrial Fraction . . . . .	33
4. Cell Wall Fraction . . . . .	33
5. Association of Enzymes with Larger Particles . . . . .	33
6. Isolation of Plant Protoplasts . . . . .	34
7. Localization of Phosphatases . . . . .	34
IV. Phosphatases Acting on Hexose Phosphates . . . . .	35
1. The Hydrolysis of Glucose-1-Phosphate . . . . .	35
2. C <sub>1</sub> Diphosphatases . . . . .	36
a) Fructose Diphosphatase . . . . .	36
b) Fructose Diphosphatase of Animal Tissue . . . . .	36
c) Fructose Diphosphatase of Plants . . . . .	37
d) Neutral Fructose Diphosphatase . . . . .	39
e) Acidic Fructose Diphosphatase . . . . .	39
f) Acid C <sub>1</sub> Diphosphatase of <i>Escherichia coli</i> . . . . .	39
g) Role of Alkaline Fructose Diphosphatase in Green Plants . . . . .	39
3. Sedoheptulose-1,7-Diphosphatase . . . . .	40
4. Glycerate-2,3-Diphosphatase . . . . .	40
V. Enzymes Acting on Condensed Phosphates . . . . .	41
1. Inorganic Pyrophosphatases . . . . .	41
a) Inorganic Pyrophosphatase of Microorganisms . . . . .	41
b) Inorganic Pyrophosphatases of Animal Tissue . . . . .	43
2. Tripolyphosphatases . . . . .	44
3. Tetrapolyphosphatases . . . . .	45
4. Trimetaphosphatases . . . . .	45
5. Tetrametaphosphatases . . . . .	47
VI. Enzymes Acting on Polyphosphates . . . . .	47
Type I Enzyme: Polyphosphate Depolymerases . . . . .	47
Type II Enzyme: Polyphosphatases . . . . .	47
a) Type I . . . . .	48
b) Type II . . . . .	49
c) Type III . . . . .	49
Type III Enzyme: Enzymes Transferring Phosphate Groups from Polyphosphates to Suitable Acceptors . . . . .	49
Polyphosphate-ADP-phosphotransferase of <i>Escherichia coli</i> . . . . .	50
VII. General Phosphomonoesterases . . . . .	50
1. Acid Phosphatases . . . . .	51
2. Alkaline Phosphatases . . . . .	51
a) Alkaline Phosphatases of Microorganisms . . . . .	52
VIII. Phosphoprotein Phosphatase . . . . .	52
IX. Ortho Phosphoserine Phosphatase . . . . .	54
X. Phosphatase Acting on Nucleotides and Nucleic Acids . . . . .	55
1. Nucleotide Pyrophosphatases . . . . .	55
a) Nucleotide Pyrophosphatase of Potato . . . . .	56
b) Nucleotide Pyrophosphatase of Tobacco . . . . .	56
2. 5'-Nucleotidases . . . . .	57
a) 5'-Nucleotidase of <i>Clostridium stricklandii</i> . . . . .	57
3. Ribonucleases . . . . .	58
a) Ribonucleases of Plants . . . . .	58
b) Endonucleases from Microorganisms . . . . .	62
c) Phosphodiesterases Acting on Polynucleotides . . . . .	62
References . . . . .	63
<b>Enzymes of Inorganic Nitrogen Metabolism.</b> By E. J. HEWITT and D. J. D. NICHOLAS. With 3 Figures . . . . .	67
A. Nitrate Reductase . . . . .	67
I. Preparation . . . . .	68
1. Fungi and Higher Plants . . . . .	68
2. Bacteria . . . . .	76
a) Methods of extraction . . . . .	76
b) Fractionation and Stability . . . . .	78
II. Measurement of Activity . . . . .	83
1. Assay Methods . . . . .	83
2. Sources of Error . . . . .	89

III. Electron Donors and Co-Factors. . . . .	91
1. Fungi and Higher Plants . . . . .	91
a) Pyridine nucleotides and other electron donors. . . . .	91
b) Flavins. . . . .	93
c) Metal and Anion Requirements . . . . .	94
2. Bacteria. . . . .	95
IV. Properties and Mechanisms. . . . .	96
1. Fungi and Higher Plants . . . . .	96
2. Bacteria. . . . .	101
V. Physiological Factors . . . . .	108
1. Fungi and Higher Plants . . . . .	108
2. Bacteria. . . . .	109
B. Other Nitrate Reduction and Nitro Reductase Enzymes. . . . .	110
1. Aldehyde and Xanthine Oxidases of Animal Origin . . . . .	110
2. Aldehyde Oxidase of Potato . . . . .	110
3. Reduction of Aromatic Nitro-Compounds . . . . .	111
C. Nitrite, Nitric Oxide, Hyponitrite and Hydroxylamine Reductases and Related Enzymes . . . . .	112
I. Preparation. . . . .	113
1. Fungi and Higher Plants . . . . .	113
2. Bacteria. . . . .	115
II. Fractionation and Stability. . . . .	115
III. Measurement of Activity . . . . .	121
1. Interference and Errors . . . . .	121
2. Assay Methods . . . . .	126
a) Use of CONWAY Methods for NH <sub>3</sub> Determinations . . . . .	126
b) Hydroxylamine . . . . .	138
c) Oximes, YAMAFUJI and AKITA (1952). . . . .	129
d) Hyponitrite . . . . .	129
e) Assay Methods Using Reduced Benzyl Viologen and Other Dyes under Anaerobic Conditions . . . . .	130
f) Manometric Assay of Nitrite Reductase . . . . .	133
g) Manometric Assay of Nitric Oxide Reductase . . . . .	136
3. Preparation of Hyponitrite as a Substrate . . . . .	136
IV. Electron Donors and Co-Factors and Inhibitors . . . . .	137
1. Fungi and Higher Plants . . . . .	137
a) Nitrite Reductase . . . . .	137
b) Hyponitrite Reductase . . . . .	141
c) Hydroxylamine Reductase . . . . .	142
2. Bacteria. . . . .	142
a) Nitrite Reductase . . . . .	142
b) Nitric Oxide Reductase . . . . .	144
c) Hydroxylamine Reductase . . . . .	146
V. Properties and Mechanisms . . . . .	146
1. Fungi and Higher Plants . . . . .	146
2. Bacteria. . . . .	148
a) Nitrite Reductase . . . . .	148
b) Nitric Oxide Reductase . . . . .	153
c) Hydroxylamine Reductase . . . . .	155
VI. Physiological Factors and Other Features . . . . .	157
1. Fungi and Higher Plants . . . . .	157
a) Nitrite Reductase . . . . .	157
b) Hydroxylamine Reductase . . . . .	158
D. Glutamic Dehydrogenase . . . . .	158
E. Oxidation and Other Reactions of Ammonia, Hydroxylamine and Nitrite . . . . .	158
I. Fungi and Higher Plants . . . . .	158
Hydroxylamine "Oxidase" of Higher Plants . . . . .	160
II. Bacteria (Enzymes of Nitrification) . . . . .	161
1. Preparation . . . . .	161
2. Measurement of Activity. . . . .	164
3. Cofactors . . . . .	164
4. Properties and Mechanisms . . . . .	166
Reversal of NH <sub>2</sub> OH reductase "Ammonia dehydrogenase" artefact . . . . .	169
Literature . . . . .	169

<b>Enzymes of Vitamin Metabolism.</b> By T. W. GOODWIN. With 5 Figures . . . . .	173
A. Enzymes Concerned with Biosynthesis . . . . .	173
1. Thiamine . . . . .	173
a) General Preparation of Enzyme Fractions . . . . .	174
b) Pyrimidine Kinase . . . . .	174
c) Thiazole Kinase . . . . .	175
d) Thiamine Phosphate Synthetase . . . . .	175
e) Thiamine Phosphatase . . . . .	175
2. Riboflavin. . . . .	175
3. Nicotinic Acid . . . . .	176
a) Tryptophan Pyrrolase . . . . .	177
b) Formylase (Kynurenine Formamidase) . . . . .	178
c) Kynurenine Hydroxylase . . . . .	178
d) Kynureninase . . . . .	179
4. Folic Acid . . . . .	179
5. Pantothenic Acid . . . . .	180
Pantothenate Synthetase . . . . .	180
B. Activating Enzymes . . . . .	180
1. Thiamine . . . . .	180
a) Thiamine Pyrophosphokinase . . . . .	180
b) Thiamine Pyrophosphate Kinase . . . . .	182
2. Riboflavin. . . . .	182
a) Flavokinase . . . . .	183
b) FAD Pyrophosphorylase . . . . .	185
3. Pyridoxal (Vitamin B.) . . . . .	186
Pyridoxal Phosphokinase . . . . .	186
4. Nicotinic Acid . . . . .	187
a) PRPP-Nicotinic Acid Transferase . . . . .	188
b) DPN-Pyrophosphorylase . . . . .	188
c) DPN-Synthetase . . . . .	189
d) DPN-Kinase. . . . .	189
6. Folic Acid . . . . .	189
a) Folic Acid Reductase . . . . .	190
b) Dihydrofolic Acid Reductase . . . . .	190
6. Pantothenic Acid . . . . .	190
a) Pantothenate Kinase . . . . .	191
b) Coupling Enzyme . . . . .	192
c) Phosphopantothenylcysteine Decarboxylase . . . . .	192
d) Dephospho-CoA Pyrophosphorylase . . . . .	192
e) Phosphotransacetylase . . . . .	193
f) Dephospho-CoA Kinase . . . . .	194
C. Degrading Enzymes . . . . .	194
1. Thiamine . . . . .	194
a) Thiaminase . . . . .	194
h) Thiamine Phosphatase . . . . .	195
e) Thiamine Pyrophosphatase . . . . .	195
2. Riboflavin . . . . .	196
a) FAD-ase (Nucleotide Pyrophosphatase) . . . . .	196
b) FMN-Phosphatase . . . . .	196
3. Nicotinic Acid . . . . .	196
a) Nucleotide Pyrophosphatase. . . . .	196
b) DPN-ase (Pyridine Transglycosidase). . . . .	197
c) NMN-Phosphatase . . . . .	197
4. Folic Acid. . . . .	198
6. Pantothenic Acid . . . . .	198
a) "CoA-3'-Nucleotidase" . . . . .	198
b) "CoA Pyrophosphatase" . . . . .	199
c) "CoA-Peptidase" . . . . .	199
6. Biotin. . . . .	199
d-Biotin Oxidase . . . . .	199
7. Inositol . . . . .	200
Phytase . . . . .	200
8. Carotene. . . . .	201

Carotene Oxidase (Lipoxidase) . . . . .	201
References . . . . .	202
<b>Enzyme des L-Ascorbinsäure-Stoffwechsels. Von H. JANECKE. Mit 7 Abbildungen . . . . .</b>	<b>204</b>
<b>I. Enzyme bei der Biosynthese der L-Ascorbinsäure . . . . .</b>	<b>204</b>
<b>1. Indirekte Umwandlung . . . . .</b>	<b>205</b>
a) Aldolkondensation . . . . .	205
b) Acyloin-Reaktion . . . . .	205
<b>2. Direkte Umwandlung . . . . .</b>	<b>207</b>
a) L-Galaktonsäure- $\gamma$ -laktondehydrogenase. . . . .	210
b) Enzympräparat nach MAPSON u. ISHERWOOD (1958) . . . . .	211
c) Enzympräparat nach NAKATANI . . . . .	211
d) L-Gulonsäuredehydrogenase nach ISHIKAWA u. NOGUCHI (1957) . . . . .	214
e) Herstellung der gereinigten Laktanase I . . . . .	214
<b>II. L-Ascorbinsäure oxydierende Enzymsysteme . . . . .</b>	<b>216</b>
1. Peroxydase . . . . .	216
2. Cytochrom c -- Cytochromoxydase . . . . .	217
3. Polyphenoloxydase . . . . .	217
4. Laccase . . . . .	218
5. Ascorbinsäureoxydase . . . . .	218
a) Methoden der Kupferbestimmung . . . . .	220
b) Eigenschaften der AS-Oxydase. . . . .	221
c) Gewinnung der Ascorbinsäure-Oxydase . . . . .	223
d) Aktivitätsbestimmungen der AS-Oxydase . . . . .	224
c) Vorkommen der AS-Oxydase . . . . .	225
6. Andere Ascorbinsäure oxydierende Enzyme . . . . .	226
<b>III. L-Ascorbinsäure reduzierende Enzymsysteme . . . . .</b>	<b>226</b>
1. Herstellung des gereinigten Enzympräparates nach JANECKE u. RAGAB . . . . .	228
2. Darstellung der L-Dehydroascorbinsäure . . . . .	229
3. Verbreitung der DXS-Reduktase . . . . .	233
<b>Literatur . . . . .</b>	<b>233</b>
<b>Enzymes Involved in the Synthesis and Breakdown of Indoleacetic Acid. By S. MAHADEVAN.</b>	
With 1 Figure. . . . .	438
<b>I. General Methods . . . . .</b>	<b>238</b>
Separations of IAA from its Precursors in the Reaction Mixture. . . . .	239
<b>TI. Enzymes Involved in the Synthesis of IAA . . . . .</b>	<b>240</b>
1. Enzymes Involved in the Conversion of TTP to IAA . . . . .	240
a) Distribution . . . . .	240
b) Pathways for the Conversion of TTP to IAA . . . . .	441
c) Conversion of IPyA to IAc and IAA . . . . .	241
d) Preparation and Properties of Some Enzymes Converting TTP to IAA . . . . .	242
2. Enzymes Involved in the Conversion of IAc to IAA . . . . .	243
Preparation of the Enzymes . . . . .	243
3. Enzymes Involved in the Conversion of TNH, to IAc and IAA . . . . .	244
4. Enzymes Involved in the Conversion of IAN to IA.4 . . . . .	246
<b>III. Enzymes Involved in the Breakdown of IAA . . . . .</b>	<b>248</b>
1. General Properties of the IAA Oxidation Reaction . . . . .	249
2. Preparation and Properties of some IAA Oxidases . . . . .	251
a) Lupin Enzyme. . . . .	251
b) Pea Enzyme. . . . .	253
c) Wheat Leaf Enzyme . . . . .	254
d) Pineapple Enzyme . . . . .	255
e) <i>Omphalia</i> Enzyme . . . . .	256
References . . . . .	268
<b>Enzymes of Aromatic Biosynthesis By TAKAYOSHI HIGUCHI and ICHJI KAWAMURA.</b>	
With 2 Figures . . . . .	260
<b>I. Enzymes of Aromatic Biosynthesis from Non-Aromatic Compounds in Microorganisms . . . . .</b>	<b>260</b>
a) 2-Keto-3-Deoxy-D-Araboheptonic Acid-7-Phosphate (KDHP) Synthetase . . . . .	262
b) The Enzyme Converting KDHP to Dehydroquininate . . . . .	265
c) Dehydroshikimic (DHS) Dehydrase . . . . .	265

d) 5-Dehydroquinase . . . . .	267
e) Quinic Dehydrogenase . . . . .	268
f) 5-Dehydroshikimic Reductase . . . . .	270
g) ATP-Shikimic Acid Transphosphorylase. . . . .	272
h) The Enzymes Forming 3-Enolpyruvyl Bhikimate-5-Phosphate (ESP) from 5-Phosphoshikimic Acid and Phosphoenolpyruvate . . . . .	273
i) Prephenic Aromatase . . . . .	274
k) Prephenic Dehydrogenase . . . . .	274
II. The Shikimic Acid Pathway in Higher Plants. . . . .	275
III. Conversion of Simple Phenylpropanoids to Lignin and Related Compounds . . . . .	277
a) Tyrase . . . . .	278
b) Phenylalanine deaminase . . . . .	281
IV. Conversion of Coniferin and Coniferyl Alcohol to Coniferous Lignin . . . . .	283
1. Dehydrogenation of Coniferyl Alcohol by Laccase and Peroxidase . . . . .	285
a) Mushroom Enzyme. . . . .	285
b) The Enzyme of Spruce Cambial Sap . . . . .	287
c) The Enzyme of Japanese Lacquer . . . . .	286
2. Coupled Oxidation of Coniferyl Alcohol by Yellow Enzyme-Peroxidase Systems. . . . .	287
References . . . . .	288

### Enzymes of Amino Acid Metabolism.

Part I: Enzymes of Ueamination, <b>Decarboxylation</b> , <b>Transmethylation</b> and <b>Intermediary Metabolism</b> . Ry B. D. SANWAL and MADHU LATA. With 7 Figures . . . . .	290
A. Enzymes of Oxidative Deamination. . . . .	291
I. Pyridine Nucleotide linked Dehydrogenases . . . . .	291
1. L-Glutamic Dehydrogenase of Higher Plants . . . . .	291
2. L-Glutamic Acid Dehydrogenase of <i>Neurospora</i> and Other Microorganisms . . . . .	293
3. L-Alanine Dehydrogenase . . . . .	294
4. L-Leucine Dehydrogenase . . . . .	295
II. D- and L-Amino Acid Oxidases . . . . .	296
1. D-Amino Acid Oxidase of Microorganisms . . . . .	297
2. D-Glutamic Acid Oxidase . . . . .	298
3. L-Amino Acid Oxidase of Microorganisms . . . . .	298
III. Amine Oxidases . . . . .	300
Amine Oxidase of Pea Seedlings . . . . .	300
B. Enzymes of Amino Acid Decarboxylation . . . . .	302
I. Amino Acid Decarboxylases of Higher Plants . . . . .	303
Glutamic Decarboxylase . . . . .	303
II. Amino Acid Decarboxylases of Microorganisms . . . . .	304
1. Glutamic Acid Decarboxylase of <i>Escherichia coli</i> . . . . .	305
2. Lysine Decarboxylase of <i>E. coli</i> . . . . .	306
3. Arginine Decarboxylase of <i>E. coli</i> . . . . .	307
4. Leucine Decarboxylase . . . . .	307
5. L-Tryptophan Decarboxylase . . . . .	308
6. Diaminopimelic Acid Decarboxylase. . . . .	308
7. Tyrosine Decarboxylase . . . . .	309
C. Enzymes of Non-Oxidative Deamination . . . . .	309
I. Amino Acid Deaminases . . . . .	309
1. Aspartase . . . . .	309
3. Histidase . . . . .	310
II. Dehydrative Deaminases . . . . .	310
1. Dehydrases . . . . .	310
a) L-Threonine (and L-Serine) Dehydrase . . . . .	310
b) D-Serine (and D-Threonine) Dehydrase . . . . .	311
2. Desulphydrases . . . . .	312
a) L-Cysteine Desulphydrase . . . . .	312
b) D-Cysteine Desulphydrase . . . . .	313
c) Homocysteine Desulphydrase . . . . .	313
III. Amino Acid C-S Cleaving Enzymes . . . . .	313
1. Methionine Dethiomethylase . . . . .	314
2. Dimethylpropionthetin Dethiomethylase . . . . .	314

3. Cystathionase . . . . .	315
4. Alliinase . . . . .	315
5. C—S-Lyase . . . . .	316
IV. Amino Acid Reductases . . . . .	317
1. Proline Reductase . . . . .	318
2. Glycine Reductase System . . . . .	318
D. Enzymes of Transmethylation . . . . .	319
I. Enzymes of Metabolism of S-Adenosylmethionine and Thetins . . . . .	321
1. Methionine Activating Enzyme . . . . .	321
2. Cleavage of S-Adenosylmethionine . . . . .	323
3. S-Methylmethionine-Homocysteine Transmethylase . . . . .	322
4. Adenosylmethionine-Homocysteine Transmethylase . . . . .	323
5. Adenosylmethionine-Nicotinic Acid Transmethylase (Nicotinic Acid Methylpherase) . . . . .	324
E. Enzymes of Biosynthesis . . . . .	323
I. Enzymes of L-Threonine Biosynthesis . . . . .	325
1. $\beta$ -Aspartokinase . . . . .	325
2. Aspartic $\beta$ -Semialdehyde Dehydrogenase . . . . .	326
3. Homoserine Dehydrogenase . . . . .	327
4. L-Homoserine Kinase . . . . .	327
5. Threonine Synthetase (Homoserine Phosphate Mutaphosphatase) . . . . .	328
II. Enzymes of L-Histidine Biosynthesis . . . . .	329
1. Imidazoleglycerol Phosphate Dehydrase . . . . .	329
2. Imidazoleacetol Phosphate Transaminase . . . . .	331
3. L-Histidinol Phosphate Phosphatase . . . . .	332
4. L-Histidinol Dehydrogenase . . . . .	332
III. Enzymes of L-Proline Biosynthesis . . . . .	333
A'-Pyrroline-5-Carboxylate Reductase . . . . .	334
IV. Enzymes of Ornithine Synthesis . . . . .	335
1. Higher Plants, Molds and Animals . . . . .	335
Ornithine $\delta$ -transaminase . . . . .	335
2. <i>Escherichia coli</i> . . . . .	336
a) Amino Acid Transacetylase . . . . .	336
b) Acetylornithine $\delta$ -Transaminase . . . . .	336
c) Acetylornithinase . . . . .	336
V. Enzymes of the Urea Cycle and Related Compounds (synthetic) . . . . .	337
1. Carbamyl Phosphate Synthesizing Enzymes . . . . .	337
2. Carbamate Kinase . . . . .	338
3. Ornithine Transcarbamylase . . . . .	338
4. Argininosuccinate Synthetase . . . . .	339
5. Argininosuccinase . . . . .	340
6. Arginase . . . . .	341
VI. Enzymes of Arginine Degradation . . . . .	342
1. Arginine Desiminase . . . . .	342
2. Citrullinase System (Citrulline Ureidase) . . . . .	343
VII. Enzymes of Synthesis of Branched-chain Amino Acids (Leucine, Isoleucine, Valine) . . . . .	343
1. Acetolactate Synthetase (Acetolactate Forming Enzyme) . . . . .	345
2. $\alpha$ -Hydroxy- $\beta$ -keto Acid Reductoisomerase . . . . .	346
3. $\alpha$ , $\beta$ -Dihydroxy Acid Dehydrase . . . . .	346
4. Branched-Chain Amino Acid Transaminase . . . . .	347
VIII. Degradation of the Branched Chain Amino Acids . . . . .	347
IX. Formation of Succinic Acid from Glutamic Acid . . . . .	347
1. Succinic Semialdehyde Dehydrogenases . . . . .	348
2. $\gamma$ -Hydroxybutyrate Dehydrogenase . . . . .	348
X. Enzymes of Synthesis of Glycine and Serine . . . . .	349
1. 3-Phosphoglycerate $\rightarrow$ Serine . . . . .	349
2. Formate $\rightarrow$ Serine . . . . .	350
a) Hydroxymethyltetrahydrofolate Dehydrogenase . . . . .	350
b) Serine Aldolase (Serine Transhydroxymethylase) . . . . .	351
3. Glycoldehyde $\rightarrow$ Glycine . . . . .	352
XI. Enzymes of Synthesis of Tryptophan . . . . .	352

1. Indole-3-Glycerol Phosphate Synthetase . . . . .	353
2. Tryptophan Synthetase . . . . .	354
References . . . . .	355
<b>Part 2: Transaminases and Racemases.</b> By B. D. SANWAL, M. W. ZINK and GEORGE DIN.	
With 1 Figure. . . . .	361
A. Transaminases. . . . .	361
I. D-Amino Acid Transaminases . . . . .	362
II. L-Amino Acid Transaminases . . . . .	363
1. Glutamate-Aspartate Transaminase . . . . .	363
a) Assay of Glutamate-Aspartate Transaminase . . . . .	363
b) Purification of the Enzyme from Plants. . . . .	366
c) Properties of the Plant Enzyme . . . . .	367
2. Glutamate-Alanine Transaminase . . . . .	368
3. Cysteinesulfinate Transaminase . . . . .	369
4. $\beta$ -Alanine ( $\beta$ -Aminoisobutyrate)-Glutamate Transaminase . . . . .	371
5. $\alpha$ -Alanine-Glycine Transaminase . . . . .	371
6. $\alpha$ -Alanine- $\beta$ -Alanine Transaminase . . . . .	372
7. $\gamma$ -Aminobutyrate-Glutamate Transaminase . . . . .	373
8. Kynurenine Transaminase . . . . .	374
9. <b>Glutamate-Phosphohistidinol</b> Transaminase . . . . .	375
10. Ornithine Transaminase . . . . .	376
11. Serine-Alanine Transaminase . . . . .	376
12. Tyrosine-Glutamate Transaminase . . . . .	377
13. Glutamine and Asparagine Transaminases . . . . .	377
14. Alanine, Phenylalanine, Glutamate-Branched Chain Amino Acids . . . . .	378
15. Other Transaminases . . . . .	379
III. Transamidination . . . . .	380
1. Assay. . . . .	381
2. Properties . . . . .	381
13. Racemases. . . . .	381
1. Alanine Racemase . . . . .	381
2. Glutamate Racemase . . . . .	383
3. Threonine Racemase . . . . .	384
4. Methionine Racemase . . . . .	385
5. Lysine Racemase . . . . .	386
6. Proline Racemase . . . . .	387
7. $\alpha$ - $\epsilon$ -Diaminopimelic Acid (DAP) Racemase . . . . .	388
8. Other Amino Acid Racemases . . . . .	389
References . . . . .	389
<b>Enzymes of Peptide and Protein Metabolism.</b> By GEORGE WEBSTER. With 11 Figures	392
A. Enzymes Concerned with Syntheses (Synthetases) . . . . .	393
I. Amide Synthesis . . . . .	393
1. Glutamine Synthetase . . . . .	393
a) Occurrence . . . . .	393
b) Assay. . . . .	393
c) Preparation . . . . .	394
d) Properties. . . . .	397
2. Asparagine Synthetase . . . . .	400
a) Occurrence . . . . .	400
b) Assay. . . . .	400
c) Preparation . . . . .	401
d) Properties. . . . .	401
II. Peptide Synthesis . . . . .	401
1. Glutamylcysteine Synthetase. . . . .	401
a) Occurrence . . . . .	402
b) Assay. . . . .	402
c) Preparation of Ulutamylcysteine Synthetase . . . . .	402
d) Properties. . . . .	403
2. Glutathione Synthetase . . . . .	403
a) Occurrence . . . . .	403
b) Assay. . . . .	403

c) Preparation . . . . .	403
d) Properties. . . . .	404
III. Protein Synthesis . . . . .	405
1. Amino Acid-Activating Enzymes . . . . .	405
a) Occurrence . . . . .	406
b) Assay. . . . .	406
c) Preparation . . . . .	407
d) Properties. . . . .	407
2. Enzymes Concerned with Protein Synthesis . . . . .	408
a) Occurrence . . . . .	408
b) Assay. . . . .	408
c) Preparation . . . . .	409
d) Properties. . . . .	409
B. Enzymes concerned with Degradation (Amidases, Peptidases and Proteases) . . . . .	412
I. Amidases. . . . .	413
Glutaminase and Asparaginase . . . . .	413
a) Occurrence . . . . .	413
b) Assay. . . . .	413
c) Preparation . . . . .	413
d) Properties. . . . .	414
II. Peptidases . . . . .	414
a) Occurrence . . . . .	416
b) Assay. . . . .	415
c) Preparation and Properties . . . . .	415
III. Proteases. . . . .	415
a) Occurrence . . . . .	416
b) Assay. . . . .	416
c) Preparation . . . . .	417
d) Properties. . . . .	417
References . . . . .	418
<b>Enzymes of Synthesis of Purine and Pyrimidine Nucleotides.</b> By DALTON WANQ and E. R. WAYGOOD. With 2 Figures . . . . .	421
A. Enzymes of Synthesis of Purine Nucleotides . . . . .	422
I. 5-Phosphoribosylpyrophosphate Kinase . . . . .	422
1. Assay. . . . .	422
2. Enzyme Preparation . . . . .	424
a) Procedures of KORNBERG et al. (1955) . . . . .	424
b) Procedures of KORN et al. (1955). . . . .	425
II. 5-Phosphoribosylpyrophosphate Amidotransferase . . . . .	426
1. Assay. . . . .	426
2. Enzyme Preparations . . . . .	427
III. Glycinamide Ribotide Kinosynthase . . . . .	429
IV. Glycinamide Ribotide Transformylase . . . . .	432
V. Formylglycinamidine Ribotide Kinosynthase . . . . .	435
VI. Enzyme for the Synthesis of 5-Aminoimidazole Ribotide . . . . .	436
VII. 5-Aminoimidazole Ribotide Carboxylase and Enzyme for the Synthesis of 5-Amino-4-Imidazole-N-Succinocarboxamide Ribotide . . . . .	436
VIII. Enzymatic Cleavage of 5-Amino-4-Imidazole-N-Succinocarboxamide Ribotide (AISCAR Splitting Enzyme) . . . . .	437
IX. 5-Amino-4-Imidazolecarboxamide Ribotide Transformylase and Inosinicase . . . . .	438
B. Enzymes of Synthesis of Pyrimidine Nucleotides . . . . .	439
I. Carbamyl Phosphate Synthetase . . . . .	439
II. Carbamyl Phosphate-Aspartate Transcarbamylase . . . . .	441
III. Dihydroorotase . . . . .	442
IV. Dihydroorotic Acid Dehydrogenase . . . . .	444
V. Orotidine-5'-Phosphate Pyrophosphorylase . . . . .	446
VI. Orotidine-5'-Phosphate Decarboxylase . . . . .	446
References . . . . .	446
<b>Enzymes of Fat Metabolism.</b>	
A. <b>Plant Lipases.</b> By EDWARD J. BARRON. With 1 Figure. . . . .	448
Assay Procedures . . . . .	448

1. Lipase Assay by the Release of Fatty Acids . . . . .	449
2. Lipase Assay by the Decrease in Ester Content . . . . .	450
3. Other Assay Procedures . . . . .	450
4. Activators and Inhibitors . . . . .	450
5. pH Optima . . . . .	451
6. Specificity of Attack. . . . .	451
7. Purification . . . . .	451
References . . . . .	452
<b>B. Phospholipases.</b> By EDWARD J. BARRON. With 1 Figure . . . . .	454
I. Phospholipase A . . . . .	454
Assay Procedure . . . . .	455
II. Phospholipase B (Lysophospholipase B) . . . . .	456
Assay Procedure . . . . .	456
a) Estimation of Activity by Measuring the Decrease in Ester Bond . . . . .	456
b) Measurement of Activity by Estimating GPC Formed. . . . .	457
c) Other Assay Procedures . . . . .	457
Substrate Specificity . . . . .	457
pH Optima and Stability . . . . .	458
Activators and Inhibitors . . . . .	458
Purification Procedures . . . . .	459
III. Phospholipase C. . . . .	459
Assay Procedure . . . . .	459
Other Assay Procedures . . . . .	460
pH Optimum and Stability . . . . .	460
Activators . . . . .	460
Substrate Specificity . . . . .	460
Purification Procedures . . . . .	460
Purification of Cottonseed Enzyme . . . . .	460
IV. Phospholipase D . . . . .	461
Assay Procedure . . . . .	461
Other Assay Procedures . . . . .	461
pH Optima and Stability. . . . .	462
Activators . . . . .	462
Substrate Specificity. . . . .	462
Purification Procedure . . . . .	462
V. Other Enzymes Attacking Phospholipids . . . . .	462
1. Phosphoinositide Phosphorylase . . . . .	462
2. Phosphatidic Acid Phosphatase . . . . .	462
3. Lysolecithin Isomerase . . . . .	463
References . . . . .	463
<b>C. <math>\beta</math>-Oxidation.</b> By P. K. STUMPF . . . . .	465
I. Even Chain Fatty Acids . . . . .	465
II. Odd-Chain Fatty Acids . . . . .	466
References . . . . .	466
<b>D. <math>\alpha</math>-Oxidation.</b> By P. K. STUMPF . . . . .	467
References . . . . .	468
<b>E. Lipoxidase.</b> By A. L. TAPPEL. . . . .	469
1. Assay Method . . . . .	469
Procedure . . . . .	469
a) Manometric . . . . .	469
b) Spectrophotometric . . . . .	469
2. Purification Procedure. . . . .	470
3. Properties . . . . .	470
References . . . . .	471
<b>F. Synthesis of Fatty Acids.</b> By EDWARD J. BARRON. . . . .	472
1. Preparation of Particles . . . . .	474
2. Extraction of Acetone Powder . . . . .	472
3. Assay. . . . .	473
4. pH Optima and Stability . . . . .	473
References . . . . .	473

<b>Enzymes of Carbohydrate Synthesis.</b> By DAVID S. FEINGOLD, ELIZABETH F. NEUFELD, and W. Z. HASSID. With 1 Figure . . . . .	474
A. Formation of Precursors of Complex Saccharides . . . . .	478
I. Preparation of Substrates . . . . .	478
II. Separation and Identification of Reaction Products . . . . .	479
III. Enzymes which Catalyze the Formation of Sugar 1-Phosphates . . . . .	481
1. D-Galactokinase from <i>Saccharomyces fragilis</i> . . . . .	481
2. D-Glucuronic Acid Kinase from <i>Phaseolus aureus</i> . . . . .	483
3. D-Galactokinase and L-Arabinokinase from <i>Phaseolus aureus</i> . . . . .	484
IV. Enzymes which Catalyze the Formation of Sugar Nucleotides . . . . .	484
1. Sugar Nucleotide Pyrophosphorylases from <i>Phaseolus aureus</i> . . . . .	486
2. UDP-D-Glucose Pyrophosphorylase from <i>Phaseolus aureus</i> . . . . .	486
3. UDP-D-Glucose Pyrophosphorylase from Brewer's Yeast . . . . .	488
4. UDP-N-Acetyl-D-Glucosamine Pyrophosphorylase from <i>Phaseolus aureus</i> . . . . .	489
5. UDP-N-Acetyl-D-Glucosamine Pyrophosphorylase from Baker's Yeast . . . . .	490
6. GDP-D-Mannose Pyrophosphorylase from Brewer's Yeast . . . . .	491
7. a-D-Galactose-1-Phosphate Uridyl Transferase from <i>Saccharomyces fragilis</i> . . . . .	492
V. Enzymes which Catalyze Transformations of Sugar Nucleotides . . . . .	492
1. 4-Epimerases. . . . .	492
a) UDP-D-Galactose 4-Epimerase from <i>Saccharomyces fragilis</i> . . . . .	493
b) 4-Epimerases from Higher Plants . . . . .	494
2. UDP-D-Glucose Dehydrogenase from Peas . . . . .	495
3. UDP-D-Glucuronic Acid Decarboxylase from Wheat Germ . . . . .	497
B. Synthesis of Disaccharides . . . . .	498
I. Enzymes which Catalyze the Formation of Sucrose and Sucrose Phosphate . . . . .	498
1. UDP-D-Glucose-D-Fructose Transglucosylase from Wheat Germ. . . . .	499
2. UDP-D-Glucose-D-Fructose 6-Phosphate Transglucosylase from Wheat Germ. . . . .	500
II. Enzyme which Catalyzes the Formation of Trehalose Phosphate (UDP-D-Glucose-D-Glucose 6-Phosphate Transglucosylase from Yeast) . . . . .	501
C. Synthesis of Glycosides . . . . .	504
I. Enzyme which Catalyzes the Formation of Diphenol D-Glucosides (UDP-D-Glucose-Diphenol Transglucosylase from Wheat Germ) . . . . .	504
II. Enzyme which Catalyzes the Formation of Phenolic Gentiobiosides (UDP-D-Glucose-Phenol-D-Glucoside Transglucosylase from Wheat Germ) . . . . .	506
D. Synthesis of Polysaccharides . . . . .	507
I. Enzyme which Catalyzes the Formation of Callose. . . . .	507
II. Enzyme which Catalyzes the Formation of Chitin . . . . .	508
III. Enzyme which Catalyzes the Formation of D-Xylohextrins . . . . .	509
IV. Enzymes which Catalyze the Formation of Starch . . . . .	510
1. Phosphorylase from Potatoes. . . . .	511
Procedure 1. . . . .	511
Procedure 2 . . . . .	512
2. Q-Enzyme (Branching Enzyme) from Potatoes . . . . .	514
3. D-Enzyme from Potatoes . . . . .	515
References . . . . .	516
<b>Enzymes of Glycolysis.</b> By MARTIN GIBBS and JOHN F. TURNER. With 1 Figure . . . . .	520
I. Assay of Glycolytic System. . . . .	520
1. Preparation of Glycolytic System . . . . .	521
2. Properties . . . . .	522
II. Phosphorylase . . . . .	522
1. Assay Method . . . . .	522
2. Purification . . . . .	523
3. Properties . . . . .	523
III. Phosphoglucomutase. . . . .	523
1. Assay Method . . . . .	524
2. Preparation of Phosphoglucomutase Extracts from Plant Tissues . . . . .	524
3. Properties. . . . .	524
IV. Hexokinase . . . . .	525
1. Assay Method . . . . .	525
2. Preparation of Hexokinase Extracts from Plant Tissues . . . . .	525
3. Properties . . . . .	526

V. Phosphoglucose Isomerase . . . . .	526
1. Assay Method . . . . .	526
2. Preparation of Phosphoglucose Isomerase Extracts from Plant Tissues . . . . .	526
3. Properties . . . . .	527
VI. Phosphohexokinase . . . . .	527
1. Assay Method . . . . .	527
2. Preparation of Phosphohexokinase from Plant Tissue . . . . .	528
3. Properties . . . . .	528
VII. Fructose-1,6-Diphosphatase . . . . .	528
1. Assay Method . . . . .	528
2. Purification Procedure (RACKER and SCHROEDER, 1958) . . . . .	529
3. Properties . . . . .	529
VIII. Aldolase . . . . .	530
1. Assay Method . . . . .	530
2. Purification Procedure . . . . .	532
3. Properties . . . . .	532
IX. Triosephosphate Isomerase . . . . .	533
Assay Method . . . . .	533
X. TPN Triosephosphate Dehydrogenase . . . . .	534
1. Assay Method . . . . .	534
2. Purification Procedure (GIBBS, 1955) . . . . .	535
3. Properties . . . . .	535
XI. DPN Triosephosphate Dehydrogenase . . . . .	535
1. Assay Method . . . . .	535
2. Purification Procedure (HAGEMAN and ARNON, 1955) . . . . .	536
3. Properties . . . . .	536
XII. Triosephosphate — Phosphoglycerate Dehydrogenase . . . . .	536
1. Assay Method . . . . .	536
2. Purification Procedure (HOSENBERG and ARNON, 1955) . . . . .	537
3. Properties . . . . .	537
XIII. Phosphoglycerate Kinase . . . . .	537
1. Assay Method . . . . .	537
2. Preparation Procedure (AXELROD and BANDURSKI, 1953) . . . . .	538
3. Properties . . . . .	539
XIV. Phosphoglyceric Acid Mutase . . . . .	539
1. Assay Method . . . . .	539
2. Purification (ITO and GRISOLIA, 1959) . . . . .	540
3. Properties . . . . .	540
XV. Enolase, 2-Phosphoglycerate Dehydrase . . . . .	541
1. Assay Method . . . . .	541
2. Purification Procedure (BOSER, 1959) . . . . .	541
3. Properties . . . . .	542
XVI. Pyruvate Kinase . . . . .	543
1. Assay Method . . . . .	543
2. Purification Procedure (MILLER and EVANS, 1957) . . . . .	543
3. Properties (Data of MILLER and EVANS, 1957) . . . . .	544
References . . . . .	544

Enzymes of the Pentose Phosphate Cycle. By E. R. WAYGOOD and R. ROHRINGER. With

I Figure . . . . .	546
I. Hexokinase (Glucokinase and Fructokinase) . . . . .	549
1. Assay . . . . .	550
2. Purification . . . . .	551
II. Glucose-6-Phosphate Dehydrogenase (Zwischenferment). Lactonase and 6-Phosphogluconic Dehydrogenase . . . . .	552
1. Assay . . . . .	552
2. Purification . . . . .	554
3. Lactonase (Assay and Purification) . . . . .	556
III. Phosphoriboisomerase . . . . .	556
1. Assay . . . . .	556
2. Purification . . . . .	557
3. Preparation of Isomerase Product . . . . .	558
IV. Phosphoketopentosepimerase and Transketolase . . . . .	558

1. Assay (Transketolase) . . . . .	559
2. Purification (Transketolase) . . . . .	560
3. Assay (Phosphoketopentosepimerase) . . . . .	562
4. Purification (Phosphoketopentosepimerase) . . . . .	563
V. Transaldolase . . . . .	564
1. Assay . . . . .	564
2. Preparation of Sedoheptulose-7-Phosphate . . . . .	565
3. Purification . . . . .	565
VI. Phosphohexoisomerase . . . . .	566
1. Assay . . . . .	566
2. Purification . . . . .	567
References . . . . .	567
<b>Enzyme Systems in Photosynthesis.</b> By MANUEL LOSADA and DANIEL I. ARNON. With 5 Figures . . . . .	
A. The Photosynthetic Structures of Plants and Bacteria . . . . .	570
I. Chloroplasts . . . . .	671
1. Isolation and Purification of Whole Chloroplasts . . . . .	571
2. Preparation of "Broken" Chloroplasts and-chloroplast Extracts . . . . .	572
II. Chromatophores . . . . .	572
1. Isolation and Purification of <i>Chromatium</i> Chromatophores . . . . .	572
a) Culture of Bacteria . . . . .	572
b) Preparation and Fractionation of Cell Extracts . . . . .	573
2. Isolation and Purification of <i>Rhodospirillum rubrum</i> Chromatophores . . . . .	574
a) Culture of Bacteria . . . . .	574
b) Preparations of Cell-Free Extracts . . . . .	574
c) Preparation of Purified Chromatophores . . . . .	574
B. Carbon Dioxide Assimilation in Photosynthesis . . . . .	574
I. Separation of Light and Dark Phases in Photosynthesis . . . . .	575
II. Characteristic Enzymes of the Reductive Carbohydrate Cycle . . . . .	577
1. Phosphoribulokinase . . . . .	577
a) Assay Method . . . . .	577
b) Purification Procedure . . . . .	578
c) Properties . . . . .	578
2. Carboxylation Enzyme . . . . .	579
a) Assay Method . . . . .	579
b) Purification Procedure (Method of WEISSBACH et al., 1956) . . . . .	579
c) Purification Procedure (Method of JAKOBY et al., 1956) . . . . .	580
d) Properties . . . . .	581
C. Photosynthetic Phosphorylation . . . . .	582
I. Cyclic Photophosphorylation . . . . .	583
1. Procedure for Cyclic Photophosphorylation in Chloroplasts . . . . .	584
2. Procedure for Cyclic Photophosphorylation in Chromatophores . . . . .	585
II. Noncyclic Photophosphorylation . . . . .	586
1. Procedure for Noncyclic Photophosphorylation in Chloroplasts . . . . .	587
2. Procedure for Noncyclic Photophosphorylation in Chromatophores . . . . .	588
D. Isolated Protein Constituents of the Photosynthetic Apparatus . . . . .	589
I. The TPN-Reducing System . . . . .	589
1. Chloroplast Ferredoxin . . . . .	592
a) Isolation and Purification . . . . .	593
b) Crystallization of Parsley Ferredoxin . . . . .	594
c) Crystallization of Spinach Ferredoxin . . . . .	595
2. Ferredoxin-TPN Reductase . . . . .	596
a) Isolation and Purification . . . . .	597
b) Assay Method . . . . .	598
c) Properties . . . . .	598
d) Crystallization Procedure . . . . .	599
II. Cytochromes in Leaves and Algae . . . . .	599
1. Extraction and Purification . . . . .	600
a) Preparation of Cytochrome f from Parsley . . . . .	600
b) Crystallization of <i>Porphyra tenera</i> -Cytochrome 553 . . . . .	600
2. Properties . . . . .	601
III. Bacterial Cytochromes . . . . .	602

1. RHP and Cytochrome $c_2$ from <i>R. rubrum</i> . . . . .	603
a) Preparation . . . . .	603
b) Properties. . . . .	603
2. RHP and Cytochrome $c_2$ from <i>Chromatium</i> . . . . .	604
3. Cytochrome-552 from <i>Rhodospseudomonas palustris</i> . . . . .	605
E. Quinone Constituents of the Photosynthetic Apparatus . . . . .	605
I. Extraction and Purification of Vitamin $K_1$ . . . . .	607
II. Extraction and Purification of Plastoquinone . . . . .	607
1. Method of CRANE (1959b) . . . . .	607
2. Method of BISHOP (1958, 1959) . . . . .	608
III. Properties of Plastoquinone. . . . .	609
IV. Role of Quinones in Photosynthetic Reactions . . . . .	610
1. Photosynthetic Phosphorylation . . . . .	610
2. Noncyclic Electron Transport . . . . .	610
3. Bacterial Photophosphorylations . . . . .	612
V. Concluding Remarks. . . . .	612
References . . . . .	613
<b>Enzymes of the Krebs Cycle, the Glyoxalate Cycle and Related Enzymes.</b> By D. D. DAVIES and R. J. ELLIS. With 2 Figures . . . . .	616
A. Enzymes of the Krebs Cycle . . . . .	616
I. Condensing Enzyme . . . . .	616
II. Aconitase . . . . .	618
III. <i>Iso</i> Citric Dehydrogenase (TPN Specific) . . . . .	620
IV. <i>Iso</i> Citric Dehydrogenase (DPN Specific) . . . . .	621
V. $\alpha$ -Keto Acid Oxidases . . . . .	621
VI. Succinyl CoA Synthetase (P Enzyme) . . . . .	623
VII. Succinic Dehydrogenase . . . . .	624
VIII. Fumarase . . . . .	627
IX. Malic Dehydrogenase . . . . .	628
E. Enzyme Activities Related to the Krebs Cycle . . . . .	629
I. Tartaric Dehydrogenase . . . . .	629
II. Malease . . . . .	629
III. Pyruvic (De) Carboxylase . . . . .	630
IV. Lactic Dehydrogenase . . . . .	632
V. Phosphoenolpyruvic Carboxylase . . . . .	634
VI. Phosphoenolpyruvate Carboxykinase . . . . .	635
VII. Malic Enzyme . . . . .	635
C. The Glyoxalate Cycle . . . . .	636
I. Malate Synthetase. . . . .	636
II. bocitritase . . . . .	637
D. Enzymes Related to the Glyoxalate Cycle . . . . .	638
I. Glycollic Acid Oxidase . . . . .	638
II. Glyoxalic Acid Reductase . . . . .	641
III. Glycolaldehyde Dehydrogenase . . . . .	642
IV. Glycine Oxidase. . . . .	642
V. Formic Dehydrogenase. . . . .	643
References. . . . .	643
<b>Enzymes of Terminal Respiration.</b> By DAVID P. HACKETT. With 12 Figures . . . . .	647
A. Characterization of the Intact Respiratory Chain . . . . .	647
I. Measurement of Respiratory Rate . . . . .	648
1. Manometry, . . . . .	648
2. Volumetry. . . . .	648
3. Polarography. . . . .	648
4. Spectrophotometry . . . . .	649
II. Effect of Oxygen Partial Pressure on Respiratory Rate. . . . .	650
1. General Considerations . . . . .	650
2. Methods. . . . .	651
III. Coupling to Phosphorylation . . . . .	661

1. Manometric Method. . . . .	652
2. Other Methods . . . . .	652
IV. The Use of Inhibitors . . . . .	853
1. Oxidase Inhibitors . . . . .	653
2. Inhibition within the Cytochrome System . . . . .	654
3. Inhibition in the Flavoprotein Region . . . . .	655
V. Spectrophotometric Methods . . . . .	656
1. Special Problems . . . . .	657
2. Instruments . . . . .	658
3. Procedures. . . . .	659
4. Analysis of Results . . . . .	662
B. The Respiratory Chain Components. . . . .	663
I. DPNH Dehydrogenase . . . . .	663
1. Diaphorase. . . . .	664
2. Quinone Reductase . . . . .	664
3. Cytochrome c Reductase. . . . .	665
4. DPNH-Ferriyanide Reduction . . . . .	667
II. Transhydrogenase . . . . .	667
III. Cytochromes "b" . . . . .	668
IV. Cytochromes "c" . . . . .	672
V. Cytochrome Oxidase (a—a.) . . . . .	675
VI. Lipid Components (Coenzyme Q) . . . . .	677
C. Other Pathways to Oxygen . . . . .	679
I. From Pyridine Nucleotides to Oxygen . . . . .	679
1. General Considerations . . . . .	679
2. The Copper Oxidases . . . . .	681
a) Polyphenol Oxidase . . . . .	681
b) Laccase . . . . .	683
c) Ascorbic Acid Oxidase . . . . .	684
3. Peroxidases . . . . .	684
4. Glycolic Acid (a-Hydroxy Acid) Oxidase. . . . .	686
II. From other Substrates to Oxygen . . . . .	688
1. Glucose Oxidase . . . . .	688
2. Carbohydrate Oxidase. . . . .	689
References . . . . .	690
Summary of Recommendations on Enzyme! <b>Terminology.</b> (By the Commission on Enzymes of the International Union of Biochemistry, 1961) . . . . .	695
Enzyme units . . . . .	695
Symbols of enzyme kinetics . . . . .	695
The nomenclature of coenzymes . . . . .	696
Classification and nomenclature of cytochromes . . . . .	696
Classification and nomenclature of enzymes . . . . .	697
The terminology of enzyme formation. . . . .	698
"Appendix B": Recommended Symbols for Enzyme Kinetics . . . . .	699
"Appendix C": List of Cytochromes . . . . .	699
"Appendix D": Key to Numbering and Classification of Enzymes . . . . .	700
Sachverzeichnis (Deutsch-Englisch) . . . . .	702
Subject Index (English-German). . . . .	718
Table des Matières pour la Contribution: F. CHAPEVILLE et P. FROMAGEOT, Enzymes du Métabolisme du Soufre . . . . .	734