

85-1

ZEITSCHRIFT FÜR NATURFORSCHUNG

SECTION C BIOSCIENCES

Council

E. BÜNNING, Tübingen
A. BUTENANDT, München
M. EIGEN, Göttingen
W. GENTNER, Heidelberg

Editorial Board

A. HAGER, Tübingen
W. HASSELBACH, Heidelberg
P. KARLSON, Marburg
F. KAUDEWITZ, München
E. WECKER, Würzburg

Advisory Editorial Board

P. BÖGER, Konstanz
D. BÜCKMANN, Ulm
K. G. GÖTZ, Tübingen
G. GOTTSCHALK, Göttingen
H. HOFFMANN-BERLING, Heidelberg
R. JAENICKE, Regensburg
G. F. MEYER, Tübingen
M. RAJEWSKY, Essen

H. SCHIMASSEK, Heidelberg
D. SCHULTE-FROHLINDE, Mülheim/R.
F. F. SEELIG, Tübingen
J. SEELIG, Basel
H. SIMON, München
W. STEGLICH, Bonn
W. TANNER, Regensburg
A. TREBST, Bochum

EDITED IN COLLABORATION
WITH THE INSTITUTES OF THE MAX-PLANCK-GESELLSCHAFT

VOLUME 34c

NUMBER 9/10

SEPTEMBER/OCTOBER 1979

VERLAG DER ZEITSCHRIFT FÜR NATURFORSCHUNG
TÜBINGEN

34c, 9-12
1979

Subject Index

Original Communications and Notes

- Absorption Spectroscopy
Spectroscopic and Thermodynamic Studies of Chlorophyll Containing Monolayers and Vesicles. Part II: Chlorophyll a and Pheophytin a Aggregation on DMPC Vesicles 406
- Acantholide
Potential Anticancer Agents, XI. X-Ray Structure Determination of Acantholide [1] 677
- Acanthospermum glabratum*
Potential Anticancer Agents, XI. X-Ray Structure Determination of Acantholide [1] 677
- Acatalasemia*
Absence of Microsomal Lipid Peroxidation in Acatalasemic Mice (N) 301
- Accessory Pigment
Sensory Transduction in *Halobacterium halobium*: Retinal Protein Pigment Controls UV-Induced Behavioral Response 841
- Accumulation
Types of Selective Action by Herbicides which Inhibit Photosynthesis 900
- Acer pseudoplatanus*
The Molecular Weight of rRNA Precursor Molecules and Their Processing in Higher Plant Cells 253
- Acetylcholinesterase
The Acetylcholinesterase of *Bungarus multicinctus* Venom. Purification and Properties 27
Attempts to Enrich and to Solubilize the Muscarinic Acetylcholinereceptor from Bovine Caudate nucleus 51
- Acetylcholinesterase from Bovine Erythrocytes. Purification and Properties of the Enzyme Solubilized in the Presence and the Absence of Triton X-100 721
- Actin
Complex Influence of Cytochalasin B on Actin Polymerization 555
- Action Spectrum
Characterization of a Light-Induced Oxygen-Uptake in Tobacco Protoplasts 570
- Activity
Free-Running Human Circadian Rhythms in Svalbard 470
- Acyl Lipids
Radioactive Labelling of Lipids in Rat Neurosarcoma by Intravenous Injection of [^{14}C]-Octadecenol (N) 885
- Acylation Mechanism
A Possible Mechanism for a Light-Driven Regulation of the Fatty Acid Composition in Galactolipids of Chloroplasts 815
- Adenosine Analogs
Ribose Conformations of Adenosine Analogs Modified at the 2', 3' or 5' Positions 1075
- Adenosine Deaminase
Immobilization of Adenosine-Acetals with Variable Alkylidene Residues – the Function of the Spacer during Enzymatic Deamination – . . 350
- Adenylylsulfate Isolation
Improved Synthesis and Rapid Isolation of Millimole Quantities of Adenylylsulfate 346
- Adenylylsulfate Synthesis
Improved Synthesis and Rapid Isolation of Millimole Quantities of Adenylylsulfate 346
- Affinity Chromatography
The Acetylcholinesterase of *Bungarus multicinctus* Venom. Purification and Properties 27
- Affinity Chromatography
Separation of the S-Adenosylmethionine: 5- and 8- Hydroxyfuranocoumarin O-Methyltransferases of *Ruta graveolens* L. by General Ligand Affinity Chromatography 387
- Acetylcholinesterase from Bovine Erythrocytes. Purification and Properties of the Enzyme Solubilized in the Presence and the Absence of Triton X-100 721
- Affinity Resins
Immobilization of Adenosine-Acetals with Variable Alkylidene Residues – the Function of the Spacer during Enzymatic Deamination – . . 350
- Aggregation
Spin-Lattice-Relaxationtime- T_1 Measurements of Hyaluronic Acid 508
- APS-Reductase
Improved Synthesis and Rapid Isolation of Millimole Quantities of Adenylylsulfate 346
- Albumins
Rates of *de novo* Synthesis of Malate Synthase and Albumins during the Very Early Phase of Germination 1237
- Alcohol Dehydrogenase
Search for Millimeter Microwave Effects on Enzyme or Protein Functions 60
- Aldehyde Oxidase
A New Mutant Affecting Aldehyde Oxidase in *Drosophila melanogaster* (N) 304
- Aldox-2
A New Mutant Affecting Aldehyde Oxidase in *Drosophila melanogaster* (N) 304
- Algae
Biological Systems to Assay Herbicidal Bleaching 1044
- Algae
Influence of Bleaching Herbicides on Chlorophyll and Carotenoids 1047
- Algal Cells
Induction of Reversible Tolerance of Algal Cells to Various Herbicides. I. Inhibition of Photosynthesis by Phenol Herbicides and Dibromothymoquinone, Its Reversal and Development of Insensitivity to Different Herbicides 951
- Algal Excretion Product
The Algal Excretion Product, Geranylacetone: A Potent Inhibitor of Carotene Biosynthesis in *Synechococcus* 957

- n*-Alkanes, *n*-Alkanols
The Wax of *Calathea luica* (Marantaceae) (N) 157
- Alkoxy lipids
Radioactive Labelling of Lipids in Rat Neurosarcoma by Intravenous Injection of [^{14}C]-Octadecenol (N) 885
- O-Alkylfurocoumarins
The Role of 5-Hydroxymarmesin in the Biogenesis of Bergapten (N) 1278
- Alkylating Agents
A Theoretical Study of H_3PO_4 , nor-N-Mustard, and Cyclophosphamide 658
- All-or-Flip-or-None Response
All-or-None Behaviour and Bistability in a Simple Cell Model with Autocatalysis of Type A + 2 B = 3 B (N) 649
- Allethrin
Inhibitory Effects of the Insecticides Allethrin, Lindane, and Jacutin-Fogetten Sublimate on Photosynthetic Electron Transport 1070
- Amanita phalloides*
Amanitin Content and Toxicity of *Amanita verna* Bull. 330
- Amanita phalloides*
Determination of α -, β -, and γ -Amanitin by High Performance Thin-Layer Chromatography in *Amanita phalloides* (Vaill. ex Fr.) Secr. from Various Origin 1133
- Amanita verna*
Amanitin Content and Toxicity of *Amanita verna* Bull. 330
Determination of α -, β -, and γ -Amanitin by High Performance Thin-Layer Chromatography in *Amanita phalloides* (Vaill. ex Fr.) Secr. from Various Origin 1133
- Amino Acid Sequence
Stained Native Collagen: Interpretation of the Small Angle X-ray Scattering and Electron Microscopic Pictures in Terms of the Primary Structure 13
- Amino Acids
Isolation and Characterization of Vacuoles from Cell Suspension Cultures of *Daucus carota*
- Amino Acids
Selective Effects of Lindane (γ -1,2,3,4,5,6 Hexachlorocyclohexane) on Photosynthesis, Membrane Transport of Amino Acids and Protein Synthesis in *Anacystis nidulans* 1062
Expression of Aspartokinase, Dihydrodipicolinic Acid Synthase and Homoserine Dehydrogenase During Growth of Carrot Cell Suspension Cultures on Lysine- and Threonine-Supplemented Media 1178
- Aminocyclitol
Studies on the Chemistry of Lichens, XIX. New Amino Compounds from *Anaptychia fusca* and Several *Stereocaulon* Species 493
- Aminohexitol
Studies on the Chemistry of Lichens, XIX. New Amino Compounds from *Anaptychia fusca* and Several *Stereocaulon* Species 493
- α -Aminoxy- β -phenylpropionic Acid
Effects of α -Aminoxy- β -phenylpropionic Acid on Phenylalanine Metabolism in *p*-Fluorophenylalanine Sensitive and Resistant Tobacco Cells 770
- L- α -Aminoxy- β -phenylpropionic Acid
Interference of L- α -Aminoxy- β -Phenylpropionic Acid with Phenylalanine Metabolism in Buckwheat 1162
- Aminopentitol
Studies on the Chemistry of Lichens, XIX. New Amino Compounds from *Anaptychia fusca* and Several *Stereocaulon* Species 493
- Amitrol
The Effect of PS II Herbicides, Amitrol and SAN 6706 on the Activity of 3-Hydroxy-3-methylglutaryl-coenzyme-A-Reductase and the Incorporation of [^{14}C]-Acetate and [^3H]-Mevlonate into Chloroplast Pigments of Radish Seedlings 941
- Amperometric SH Titration
NADPH-Dependent Thioredoxin Reductase and a New Thioredoxin from Wheat 214
- Anacystis nidulans*
Selective Effects of Lindane (γ -1,2,3,4,5,6 Hexachlorocyclohexane) on Photosynthesis, Membrane Transport of Amino Acids and Protein Synthesis in *Anacystis nidulans* 1062
- Anaerobic and Aerobic Microorganisms
Degradation and Metabolization of Lindane and other Hexachlorocyclohexane Isomers by Anaerobic and Aerobic Soil Microorganisms 1066
- B_{12} -Analogues
Synthesis and Spectra (Electronic, CD) of the Co(I) Form of Several Natural Corrinoids 689
- Anatomy
Isolation of Anatomical Brain Mutants of *Drosophila* by Histological Means 143
- Angular Furocoumarins
 T_2 Phage Sensitization by Linear and Angular Furocoumarins 811
- Anti-Feedant
Precocene II is no Anti-Juvenile Hormone in the Honey Bee, *Apis mellifera* 1261
- Anti-Juvenile Hormone
Precocene II is no Anti-Juvenile Hormone in the Honey Bee, *Apis mellifera* 1261
- Antibiotics
The Influence of Different Solvents on the Interaction between Metal Ions and Tetracycline 1156
Inhibition of Protein Synthesis in Chloroplasts from Plant Cells by Virginiamycin 1195
- Antibodies
Binding of Antibodies onto the Thylakoid Membrane. V. Distribution of Proteins and Lipids in the Thylakoid Membrane 1199
Inhibition of Photosynthetic Electron Transport in Tobacco Chloroplasts and Thylakoids of the Blue Green Alga *Oscillatoria chalybea* by an Antiserum to Synthetic Zeaxanthin 1219
- Antimicrobial Activity
Antimicrobial Activity of Quaternary Ammonium Salts of Some Saturated Heterocycloalkyl Amines [1] (N) 485
- Antipyrin
Metabolism of Chloridazon and Antipyrin in Plant Cell Suspension Cultures 914
- Antitumor Activity
Molybdocene Dichloride as an Antitumor Agent 1174
- Apatite Solubility
Empirical Border Lines of the Apatite Stability

- Field in the System $\text{CaO} - \text{P}_2\text{O}_5 - \text{H}_2\text{O} - \text{Na}_2\text{O} - \text{CO}_2 - \text{MX}$ at Room Temperature 165
- Apis mellifera* L.
Pesticides and Honey Bees: The Danger of Microencapsulated Formulations 153
Precocene II is no Anti-Juvenile Hormone in the Honey Bee, *Apis mellifera* 1261
- Aqueous Solution
Radiation Aggregates of Insulin 1139
- Arginine and Histidine Residues
Inhibition of *E. coli* L-Asparaginase by Reaction with 2,3-Butanedione. Chemical Modification of Arginine and Histidine Residues 742
- Aromatic Amino Acids
Interference of L- α -Aminooxy- β -phenylpropionic Acid with Phenylalanine Metabolism in Buckwheat 1162
- Arrhenius Equation
Temperature-Dependence of Biological Process 474
- Artificial Membranes
Interactions between Photosynthetic Pigments Bound to Lipid and Protein Particles. Spectroscopic Properties 582
- Asclepiadaceae
Investigations on *Hoya species*, II. Latex Lipids and Leaf Phenolics of *Hoya bella* Hook 5
Investigations on *Hoya* Species, III. Leaf Phenolics and Latex Lipids of *Hoya lacunosa* Bl. 1125
- Ascorbic Acid
On the Possible Involvement of Ascorbic Acid and Copper Proteins in Leukemia, III. ESR Investigations on the Interaction between Ascorbic Acid and Some Transition Metal Ions 546
On the Possible Involvement of Ascorbic Acid and Copper Proteins in Leukemia, IV. ESR Investigations on the Interaction between Ascorbic Acid and Some Copper Proteins 550
- Aspirin
In vitro Action of Gastric Mucosal Lysosomal Enzymes on Intracellular Gastric Glycoproteins 90
- Assimilates
Accumulation of Photoassimilatory Products by Phycobiliprotein-Containing Algae with Special Reference to *Cyanidium caldarium* 1209
- Assimilation of CO_2
Effect of Divalent Cations on Cation Fluxes Across the Chloroplast Envelope and on Photosynthesis of Intact Chloroplasts 233
- Association Phenomena
Spin-Lattice-Relaxationtime T_1 Measurements of Nucleosides 503
- ATPase
On the Oligomycin-Sensitivity and Subunit Composition of the ATPase Complex from *Rhodospirillum rubrum* 229
- F_1 ATPase Complexes
Purification, Subunit Structure, and Kinetics of the Chloroform-Released F_1 ATPase Complex from *Rhodospirillum rubrum* and Its Comparison with F_1 ATPase Forms Isolated by Other Methods 38
- K^+ -ATPase
Permeability of Plasma Membrane Vesicles to Ouabain and Mg^{2+} as a Factor Determining Rate of Binding of Ouabain to Na^+ and K^+ Dependent ATPase 1224
- Autocatalysis
All-or-None Behaviour and Bistability in a Simple Cell Model with Autocatalysis of Type $A + 2 B \rightarrow 3 B$ (N) 649
- Azidoquinones
Inhibitors of Photosynthetic Electron Transport. The Properties of Diazidodialkylbenzoquinones (N) 490
- Azotobacter vinelandii*
Evidence for Carbon Monoxide Insensitive Respiration in the Aerobic Nitrogen Fixing Bacteria *Azotobacter vinelandii* OP and *Xanthobacter autotrophicus* GZ 29 576
- Bacteria
Sensory Transduction in *Halobacterium halobium*: Retinal Protein Pigment Controls UV-Induced Behavioral Response 841
- Bacterial Cell Wall
Structural Investigations on Lipopolysaccharides of Mutants S SF 1111 and R 595 SF 1167 of *Salmonella minnesota* 171
- Bacteriochlorophyll-Protein Complexes *Rhodopseudomonas capsulata*
Protein Subunits of Bacteriochlorophylls B 802 and B 855 of the Light-Harvesting Complex II of *Rhodopseudomonas capsulata* 196
- Bacteroids
On the DNA Content of the Bacteroids of *Rhizobium japonicum* 793
- Bacteriorhodopsin
Sensory Transduction in *Halobacterium halobium*: Retinal Protein Pigment Controls UV-Induced Behavioral Response 841
- Bark of *Pinus silvestris*
Studies on the Chemistry of Lichens, XX. The Element Concentration of the Lichen Species *Alectoria fremontii* and Its Associated Bark Substrate of *Pinus silvestris* (N) 1275
- Batatasin I
Isolation of Batatasin I from *Dioscorea dumetorum* Rhizomes (N) 288
- Bee
Response Characteristics and Identification of Extrinsic Mushroom Body Neurons of the Bee 612
- Beta-Stimulants
Cultured Lung Cells: Interplay Effects of Beta-Mimetics, Prostaglandins and Corticosteroids in the Biosynthesis of Dipalmitoyl Lecithin 101
- Betaine
A Near-Infrared Spectroscopic Investigation of Water in Solutions with Proline, Glycinebetaine, Glycerol and Albumin 699
- Bentazone
Effect of Biocides on the Development of the Photosynthetic Apparatus of Radish Seedlings Grown under Strong and Weak Light Conditions 936
The Effect of PS II Herbicides, Amitrol and SAN 6706 on the Activity of 3-Hydroxy-3-Methylglutaryl-Coenzyme-A-Reductase and the Incorporation of $[2\text{-}^{14}\text{C}]$ -Acetate and $[2\text{-}^3\text{H}]$ -Mevalonate into Chloroplast Pigments of Radish Seedlings 941
Inhibition of Photosynthesis by Bentazon in Intact Plants and Isolated Cells in Relation to the pH 944
- Bile Pigments
Thioether Formation of Phycocyanobilin: A Model Reaction of Phycocyanin Biosynthesis 192

- Bilin Conformation
The Conformation of Bilin Chromophores in Biliproteins: Ramachandran-Type Calculations 1085
- Biliproteins
Chemical Modification of Biliprotein Chromophores 776
- Bioassays
Biological Determination of Photosynthetic Inhibitors in Soils and Water and Application of Bioassays to Herbicide Investigations 964
- Biogenesis
The Role of 5-Hydroxymarmesin in the Biogenesis of Bergapten (N) 1278
- Biospheric CO₂
¹³Carbon-Isotope Decrease in Annual-Rings of Twentieth-Century Trees (N) 644
- Biosynthesis
The Incorporation of [1,2-¹³C₂] Acetate into Pisatin to Establish the Biosynthesis of Its Polyketide Moiety 87
Evidence for the Existence of Two β -Carotene Pools and Two Biosynthetic β -Carotene Pathways in the Chloroplast 1205
- Biosynthetic Model Mechanism
A Model Mechanism for the Enzymatic Synthesis of Lupin Alkaloids 704
- Biosynthetic Pathways
Cultured Lung Cells: Effects of Isotopic Dilution and Some Undefined Stimulation on the Incorporation of Radiolabeled Palmitate and Choline into Phosphatidyl Choline (Lecithin) 96
- Bistability
All-or-None Behaviour and Bistability in a Simple Cell Model with Autocatalysis of Type A + 2 B = 3 B (N) 649
- Bleaching Herbicides
Biological Systems to Assay Herbicidal Bleaching 1044
Influence of Bleaching Herbicides on Chlorophyll and Carotenoids 1047
- Blue-Green Algae
Inhibition of Photosynthetic Electron Transport in Tobacco Chloroplasts and Thylakoids of the Blue Green Alga *Oscillatoria chalybea* by an Antiserum to Synthetic Zeaxanthin 1218
- Body Temperature
Free-Running Human Circadian Rhythms in Svalbard 470
- Bovine Erythrocytes
Acetylcholinesterase from Bovine Erythrocytes. Purification and Properties of the Enzyme Solubilized in the Presence and the Absence of Triton X-100 721
- Brain
Isolation of Anatomical Brain Mutants of *Drosophila* by Histological Means 143
Response Characteristics and Identification of Extrinsic Mushroom Body Neurons of the Bee 612
- Branched Hydrocarbons
The Chemical Composition of Cuticular Lipids from Dragonflies (Odonata) 498
- Brasoside-tetraacetat
Hastatosid, ein neues Iridoid aus *Verbena hastata* L. und *Verbena officinalis* L. [1] 311
- Brassicaceae
Sinapine Esterase. I. Characterization of Sinapine Esterase from Cotyledons of *Raphanus sativus* 715
- 5-Bromo-2-deoxyuridine
Incorporation of 5-Bromo-2-deoxyuridine into the Chloroplast DNA of *Anemia phyllitidis* 449
- Bromonitrothymol
Comparison of the Inhibition of Photosynthetic Reactions in Chloroplasts by Dibromothymoquinone, Bromonitrothymol and Ioxynil 419
Inhibition of Photosynthetic Electron Flow by Phenol and Diphenylether Herbicides in Control and Trypsin-Treated Chloroplasts 986
- Bungarus multicinctus*
The Acetylcholinesterase of *Bungarus multicinctus* Venom. Purification and Properties 27
- 2,3-Butanedione
Inhibition of *E. coli* t-Asparaginase by Reaction with 2,3-Butanedione. Chemical Modification of Arginine and Histidine Residues 742
- Ca²⁺
Density-Dependent Growth Adaptation Kinetics in 3T3 Cell Populations Following Sudden [Ca²⁺] and Temperature Changes. A Comparison with SV 40-3T3 Cells 279
- Cajanus*
A Revised Structure for the Phytoalexin Cajanol (N) 159
- Calathea lutea*
The Wax of *Calathea lutea* (Marantaceae) (N) 157
- Calcium Phosphate
Empirical Border Lines of the Apatite Stability Field in the System CaO - P₂O₅ - H₂O - Na₂O - CO₂ - MX at Room Temperature 165
- Calf Satellite I DNA
Molecular Cloning of the Restriction Fragments Derived from Double EcoRI/PstI Digestion of the Calf Satellite I DNA and Their Restriction Analysis 1151
- Calf Thymus DNA
Circular Dichroism and Ultraviolet Absorbance of Calf Thymus DNA in Presence of CH₃HgOH 259
- Callus Cells
The Molecular Weight of rRNA Precursor Molecules and Their Processing in Higher Plant Cells 253
- Callus Cultures
Enrichment of *Solanum khasianum* Callus Generating Rootlets with Steroidal Glycoalkaloids A Review of the Place of *in vitro* Cell Culture Systems in Studies of Action, Metabolism and Resistance of Biocides Affecting Photosynthesis 905
- Candida tropicalis* CBS 94
Purification and Properties of a Catechol Methyltransferase of the Yeast *Candida tropicalis* 709
- Caragana*
Phytoalexin Production by Species of the Genus *Caragana* (N) 293
- Carbamino Compounds of Haemoglobin
The Cooperativity of the CO₂ Hb Binding: Measurement by ¹³C-NMR Spectrometry 1112
- Carbon-13
Comparison of the Deuterium and Carbon-13 Contents of Ethanol Obtained by Fermentation and Chemical Synthesis 1
- Carbon Monoxide
Evidence for Carbon Monoxide Insensitive Respiration in the Aerobic Nitrogen Fixing

- Bacteria *Azotobacter vinelandii* OP and *Xanthobacter autotrophicus* GZ 29 576
- Carbonate Incorporation
Empirical Border Lines of the Apatite Stability Field in the System $\text{CaO} - \text{P}_2\text{O}_5 - \text{H}_2\text{O} - \text{Na}_2\text{O} - \text{CO}_2 - \text{MX}$ at Room Temperature 165
- Cardenolide Biogenesis
Cardenolide Biogenesis and Translocation in *Convallaria majalis* L. 334
- Cardiac Glycoside
Permeability of Plasma Membrane Vesicles to Ouabain and Mg^{2+} as a Factor Determining Rate of Binding of Ouabain to Na^+ and K^+ Dependent ATPase 1224
- Cardiac Muscle
Fine Structure and Organization of the Sarco-plasmic Reticulum in the Sino-Auricular Fibres of Frog Heart 865
- β -Carotene
Evidence for the Existence of Two β -Carotene Pools and Two Biosynthetic β -Carotene Pathways in the Chloroplast 1205
- β,β -Carotene-2-one
Presence and Biosynthetic Implications of β,β -Carotene-2-one in the Moth *Cerura vinula* (N) 483
- C_{30} -Carotenoic Acid Glucosyl Ester
New C_{30} -Carotenoic Acid Glucosyl Esters from *Pseudomonas rhodos* 181
- Carotenoid Biosynthesis
Carotenoid Biosynthesis - a Target for Herbicide Activity 979
- Carotenoids
Presence and Biosynthetic Implications of β,β -Carotene-2-one in the Moth *Cerura vinula* (N) 483
Sensory Transduction in *Halobacterium halobium*: Retinal Protein Pigment Controls UV-Induced Behavioral Response 841
Influence of Bleaching Herbicides on Chlorophyll and Carotenoids 1047
PYRIDAZINONES, Their Influence on the Biosynthesis of Carotenoids and the Metabolism of Lipids in Plants (Survey of Literature) 1052
Evidence for the Existence of Two β -Carotene Pools and Two Biosynthetic β -Carotene Pathways in the Chloroplast 1206
- Cause for Increasing Herbicide Usage
Modern Agriculture and Herbicides 895
- Catalase Inhibitors
Absence of Microsomal Lipid Peroxidation in Acatalasemic Mice (N) 301
- Catalase
On the Action of Chlorosis-Inducing Herbicides in Leaves 1036
- Catalytic Subunit
Catalytic Subunit of Adenosine Cyclic 3',5' Monophosphate-Dependent Protein Kinase from Rat Muscle: Basic Properties and Factors Influencing the Activity 1187
- Catechol Methyltransferase
Purification and Properties of a Catechol Methyltransferase of the Yeast *Candida tropicalis* 709
- Catechols
Purification and Properties of a Catechol Methyltransferase of the Yeast *Candida tropicalis* 709
- Cation Effects
Cation Effects on System II Reactions in Thylakoids: Measurements on Oxygen Evolution, the Electrochromic Change at 515 Nanometers, the Primary Acceptor and the Primary Donor 826
- CD-Spectra
Synthesis and Spectra (Electronic, CD) of the Co(I) Form of Several Natural Corrinoids 689
- 3T3 Cell
Density-Dependent Growth Inhibiting Interactions between 3T3 and SV 40-3T3 Cells in Mixed Cultures 272
- 3T3 Cells
Density-Dependent Growth Adaptation Kinetics in 3T3 Cell Populations Following Sudden $[\text{Ca}^{2+}]$ and Temperature Changes. A Comparison with SV 40-3T3 Cells 279
- Cell Division
Photosensibilisierung isolierter Mesophyllzellen von *Calystegia sepium* L. 1215
- Cell-Free Polyphenylalanine Synthesis
 γ -Irradiated Ribosomes from *Micrococcus radiodurans* in a Cell-Free Protein Synthesizing System 565
- Cell Interactions
Density-Dependent Growth Inhibiting Interactions between 3T3 and SV 40-3T3 Cells in Mixed Cultures 272
- Cell-Lysis
Protamine and Polyarginine Bacteriolysis. Similarities in Its Mechanism with Chromatin DNA Pcnosis 1144
- Cell Membrane
The *in vitro* and *in vivo* Stability of the Entrapment of Methotrexate in Negatively Charged Liposomes after Sterile Filtration 114
- Cell Model
All-or-None Behaviour and Bistability in a Simple Cell Model with Autocatalysis of Type $A + 2 B = 3 B$ (N) 649
- Cell Motility
Complex Influence of Cytochalasin B on Actin Polymerization 555
- Cell Proliferation
Proliferation and Metabolic Activities of Ehrlich Ascites Tumor Cells in Chemically Defined Albumin Media 805
- Cell Suspension Cultures
A Model Mechanism for the Enzymatic Synthesis of Lupin Alkaloids 704
Metabolism of Chloridazon and Antipyrin in Plant Cell Suspension Cultures 914
- Central Nervous System
Biological Effects of Electromagnetic Fields 616
- Cerura*
Presence and Biosynthetic Implications of β,β -Carotene-2-one in the Moth *Cerura vinula* (N) 483
- Cerebrosides
Structure of Cerebrosides. II. Small Angle X-Ray Diffraction Study of Cerasine 1121
- Chemical Syntheses
A ^1H NMR Study of the *Syn-Anti* Dynamic Equilibrium in Adenine Nucleosides and Nucleotides with the Aid of Some Synthetic Model Analogues with Fixed Conformations 359
- Chemically Defined Albumin Media
Proliferation and Metabolic Activities of Ehrlich Ascites Tumor Cells in Chemically Defined Albumin Media 805

- Chemotaxonomy
 Iridoids in *Verbena* and Some Other Verbenoideae 319
 Accumulation of Photoassimilatory Products by Phycobiliprotein-Containing Algae with Special Reference to *Cyanidium caldarium* 1209
- Chlorella*
 Influence of Divalent Foreign Cations on the Uptake of Zinc by *Chlorella* 751
- Chloretethyl-Hydrazones
 Synthesis, Biochemistry and Cytostatic Effects of N-Methyl-N- β -chloretethyl-hydrazones of Metalloocene Aldehydes 670
- Chloridazon
 Metabolism of Chloridazon and Antipyrin in Plant Cell Suspension Cultures 914
- Chlorophyll
 Spectroscopic and Thermodynamic Studies of Chlorophyll Containing Monolayers and Vesicles. Part II: Chlorophyll a and Pheophytin a Aggregation on DMPC Vesicles 406
 Effect of Biocides on the Development of the Photosynthetic Apparatus of Radish Seedlings Grown under Strong and Weak Light Conditions 936
 The Effect of PS II Herbicides, Amitrol and SAN 6706 on the Activity of 3-Hydroxy-3-Methylglutaryl-Coenzyme-A-Reductase and the Incorporation of [2-¹⁴C]-Acetate and [2-³H]-Mevallionate into Chloroplast Pigments of Radish Seedlings 941
 Influence of Bleaching Herbicides on Chlorophyll and Carotenoids 1047
 PYRIDAZINONES, Their Influence on the Biosynthesis of Carotenoids and the Metabolism of Lipids in Plants (Survey of Literature) 1052
 Influence of Aminotriazol on the Biosynthesis of Chlorophyll and Phytol 1055
- Chlorophyll Bleaching
 Ethane Formation and Chlorophyll Bleaching in DCMU-Treated *Euglena gracilis* Cells and Isolated Spinach Chloroplast Lamellae 1040
- Chlorophyll Fluorescence Induction
 Inhibition of Photosynthesis by Bentazon in Intact Plants and Isolated Cells in Relation to the pH 944
- Chloroplast Development
 The Variation of the Electrochromic Difference Spectrum at Various Stages of the Chloroplast Development 120
 Effect of Biocides on the Development of the Photosynthetic Apparatus of Radish Seedlings Grown under Strong and Weak Light Conditions 936
- Chloroplast Envelope
 Effect of Divalent Cations on Cation Fluxes Across the Chloroplast Envelope and on Photosynthesis of Intact Chloroplasts 233
- Chloroplast Pigments
 Carotenoid Biosynthesis – a Target for Herbicide Activity 979
- Chloroplast Sensitivity
 Types of Selective Action by Herbicides which Inhibit Photosynthesis 900
- Chloroplasts
 Changes of the Amounts of Pigments and Prenylquinones in Chloroplasts of *Hordeum vulgare* – Seedlings Treated with the Growth Regulating Herbicide MCPA (4-Chloro-2-methylphenoxyacetic Acid) 106
 Effect of Simazine on Formation of Chloroplasts Prenylipids in Seedlings of *Hordeum vulgare* L. 110
 Evidence for a Rapid Oxygen-Uptake in Tobacco Chloroplasts 414
 The Effect of Antibodies to Violaxanthin on Photosynthetic Electron Transport 427
 Incorporation of 5-Bromo-2-deoxyuridine into the Chloroplast DNA of *Anemia phyllitidis* 449
 Differential Effects of Herbicides upon Trypsin-Treated Chloroplasts 1015
 Inhibition of Protein Synthesis in Chloroplasts from Plant Cells by Virginiamycin 1195
 Binding of Antibodies onto the Thylakoid Membrane. V. Distribution of Proteins and Lipids in the Thylakoid Membrane 1199
 Inhibition of Photosynthetic Electron Transport in Tobacco Chloroplasts and Thylakoids of the Blue Green Alga *Oscillatoria chalybea* by an Antiserum to Synthetic Zeaxanthin 1218
- Chlorosis-Inducing Herbicides
 On the Action of Chlorosis-Inducing Herbicides in Leaves 1036
- Chorismate Mutase
 Effects of α -Aminoxy- β -phenylpropionic Acid on Phenylalanine Metabolism in *p*-Fluorophenylalanine Sensitive and Resistant Tobacco Cells 770
- Chromatin Staining
 Observations on the Chromatin Staining by Aluminium-Hematoxylin (N) 1285
- Chromatography
 Amanitin Content and Toxicity of *Amanita verna* Bull. 330
 Determination of α -, β -, and γ -Amanitin by High Performance Thin-Layer Chromatography in *Amanita phalloides* (Vaill. ex Fr.) Secr. from Various Origin 1133
- Chromic Acid Degradation
 Thioether Formation of Phycocyanobilin: A Model Reaction of Phycocyanin Biosynthesis 192
- Chromophore Modification
 Chemical Modification of Biliprotein Chromophores 776
- Circadian Rhythms
 Free-Running Human Circadian Rhythms in Svalbard 470
- Circular Dichroism
 Circular Dichroism and Ultraviolet Absorbance of Calf Thymus DNA in Presence of CH₃HgOH 259
- Citharexylum*
 Iridoids in *Verbena* and Some Other Verbenoideae 319
- Citrinin
 Action of Citrinin on Liposomes 397
- Classification
 Differential Effects of Herbicides upon Trypsin-Treated Chloroplasts 1015
- Cloning
 Molecular Cloning of the Restriction Fragments Derived from Double EcoRI/PstI Digestion of the Calf Satellite I DNA and Their Restriction Analysis 1152

- 5'-CMP
Formation of Platinum Blues by Pyrimidine Nucleotides (N) 1287
- Co(I)-corrinoids
Synthesis and Spectra (Electronic, CD) of the Co(I) Form of Several Natural Corrinoids 689
- CO₂-Cooperativity
The Cooperativity of the CO₂ Hb Binding: Measurement by ¹³C-NMR Spectrometry 1112
- CO₂-Hb-Binding Curve
The Cooperativity of the CO₂ Hb Binding: Measurement by ¹³C-NMR Spectrometry 1112
- Coli phages
Quantitative Comparison of Ribosome Binding Sites of Twelve Nucleotide Sequences from *Escherichia coli* (RNA- and DNA Phages) Based on Triplet Patterns 797
- Collagen
Stained Native Collagen: Interpretation of the Small Angle X-ray Scattering and Electron Microscopic Pictures in Terms of the Primary Structure 13
- Colony Growth
The Influence of Spermine, Spermidine and Various Sera on T-Lymphocyte and Granulocyte Colony Growth *in vitro* 452
- Color Vision
Color Vision in Salamander Larvae (N) 890
- Community Size
A Deterministic Model for Measles (N) 647
- Comparative Biotransformation
Absorption, Body Distribution, Metabolism, and Excretion of Dieldrin in Non-Human Primates and Other Laboratory Animals 340
- Competition Hybridization
Sequences Homologous to BAV Component of HL23V in Baboon Tissues 266
- Competitive Binding
On the Analysis of Competitive Binding of Various Ligands to Cooperative and Independent Binding Sites of Macromolecules 757
- Complex
Phenylalanyl-tRNA Synthetase from Baker-Yeast: Structural Organization of the Enzyme and Its Complex with tRNA^{Phe} as Determined by X-Ray Small-Angle Scattering 20
- Complexation
The Influence of Different Solvents on the Interaction between Metal Ions and Tetracycline 1157
- Complicated Reactions
The Evolution of Complicated Photoreactions in Viscous Media 1264
- Conformation
A ¹H NMR Study of the *Syn-Anti* Dynamic Equilibrium in Adenine Nucleosides and Nucleotides with the Aid of Some Synthetic Model Analogues with Fixed Conformations 359
Further Evidence for a *S-Syn* Correlation in the Purine(β)ribosides: The Solution Conformation of Two Tricyclic Analogs of Adenosine and Guanosine 653
Ribose Conformations of Adenosine Analogs Modified at the 2', 3' or 5' Positions 1075
- Conformity Indices from Alignments
Quantitative Comparison of Ribosome Binding Sites of Twelve Nucleotide Sequences from *Escherichia coli* (RNA- and DNA Phages) Based on Triplet Patterns 797
- Contrast Discrimination
The Role of Light in the Mating Behavior of *Drosophila subobscura* 1253
- Convallaria majalis*
Cardenolide Biogenesis and Translocation in *Convallaria majalis* L. 334
- Cooperativity
On the Analysis of Competitive Binding of Various Ligands to Cooperative and Independent Binding Sites of Macromolecules 757
- Copper Chelate
Mechanism of Paraquat Action: Inhibition of the Herbicidal Effect by a Copper Chelate with Superoxide Dismutating Activity 1032
- Copper Complex
On the Action of Diethyldithiocarbamate as (N) 1292
- Copper Proteins
On the Possible Involvement of Ascorbic Acid and Copper Proteins in Leukemia. IV. ESR Investigations on the Interaction between Ascorbic Acid and Some Copper Proteins 550
- Cortisol
Cultured Lung Cells: Interplay Effects of Beta-Mimetics, Prostaglandins and Corticosteroids in the Biosynthesis of Dipalmitoyl Lecithin 101
- Coumarins
Separation of the S-Adenosylmethionine: 5- and 8-Hydroxyfuranocoumarin O-Methyltransferases of *Ruta graveolens* L. by General Ligand Affinity Chromatography 391
- Crayfishes
An *in vitro* Culture System for Crayfish Organs 1243
- Cultured Cells
Proliferation and Metabolic Activities of Ehrlich Ascites Tumor Cells in Chemically Defined Albumin Media 805
- Current-Voltage Relationship
Action of Lindane on the Current-Voltage Relationship in the Plasma Membrane of *Elodea* under Passive Conditions 1072
- Cucumis sativus*
Incomplete Glyoxysomes Appearing at a Late Stage of Maturation of Cucumber Seeds 1232
Rates of *de novo* Synthesis of Malate Synthase and Albumins during the Very Early Phase of Germination 1237
- Cucurbitaceae
Herpetriol and Herpetetrol, New Lignoids Isolated from *Herpetospermum caudigerum* Wall 1129
- Cuticular Lipids
The Chemical Composition of Cuticular Lipids from Dragonflies (Odonata) 498
- Cyanide-Insensitive Respiration
On the Action of Chlorosis-Inducing Herbicides in Leaves 1036
- Cyanidium
Nor-Carotenoids as the Major Volatile Excretion Products of *Cyanidium* 186
- Cyanobacteria
External Factors Influencing Light-Induced Hydrogen Evolution by the Blue-Green Alga, *Nostoc muscorum* 820
Inhibitor
The Algal Excretion Product, Geranylacetone:

- A Potent Inhibitor of Carotene Biosynthesis in *Synechococcus* 957
- Cyanobacteria
- Distribution of Thioredoxins in Cyanobacteria (N) 1272
- Cyanophora paradoxa*
- A PAPS-Dependent Sulfotransferase in *Cyanophora paradoxa* Inhibited by 5'-AMP, 5'-ADP, and APS 222
- Cyclic AMP-Dependent Protein Kinase
- Catalytic Subunit of Adenosine Cyclic 3', 5' Monophosphate-Dependent Protein Kinase from Rat Muscle: Basic Properties and Factors Influencing the Activity 1186
- Cyclic O-2',3'-Adenosine-acetals
- Immobilization of Adenosine-Acetals with Variable Alkylidene Residues - the Function of the Spacer during Enzymatic Deamination - Cyclophosphamide 658
- A Theoretical Study of H₃PO₄, nor-N-Mustard, and Cyclophosphamide 658
- Cytochalasin
- Complex Influence of Cytochalasin B on Actin Polymerization 555
- Cytostatic Agents
- A Theoretical Study of H₃PO₄, nor-N-Mustard, and Cyclophosphamide 658
- Cytostatica
- Synthesis, Biochemistry and Cytostatic Effects of N-Methyl-N-β-chlorethyl-hydrazones of Metalloocene Aldehydes 670
- Cytotoxic Principle
- Potential Anticancer Agents, XI. X-Ray Structure Determination of Acantholide [1] 677
- Dalbergia*
- Isoflavonoid Phytoalexins from Leaflets of *Dalbergia sericea* (N) 630
- Daucus carota*
- The Molecular Weight of rRNA Precursor Molecules and Their Processing in Higher Plant Cells 253
- Expression of Aspartokinase, Dihydrodipicolinic Acid Synthase and Homoserine Dehydrogenase During Growth of Carrot Cell Suspension Cultures on Lysine- and Threonine-Supplemented Media 1177
- Dechlorination of Hexachlorocyclohexane
- Degradation and Metabolization of Lindane and other Hexachlorocyclohexane Isomers by Anaerobic and Aerobic Soil Microorganisms 1066
- Degradation
- Isolation and Characterization of Flavonol Converting Enzymes from *Mentha piperita* Plants and from *Mentha arvensis* Cell Suspension Cultures 200
- Denaturation
- Circular Dichroism and Ultraviolet Absorbance of Calf Thymus DNA in Presence of CH₃HgOH 259
- Deterministic Model
- A Deterministic Model for Measles (N) 647
- Deuterium
- Comparison of the Deuterium and Carbon-13 Contents of Ethanol Obtained by Fermentation and Chemical Synthesis 1
- Development
- Isolation of Anatomical Brain Mutants of *Drosophila* by Histological Means 143
- Development of Chemical Weed Control
- Modern Agriculture and Herbicides 895
- Development of Tolerance
- Induction of Reversible Tolerance of Algal Cells to Various Herbicides. I. Inhibition of Photosynthesis by Phenol Herbicides and Dibromothymoquinone, Its Reversal and Development of Insensitivity to Different Herbicides 951
- N,N-Dialkyl Ammonium Salts of Saturated Heterocyclic Amines
- Antimicrobial Activity of Quaternary Ammonium Salts of Some Saturated Heterocycloalkyl Amines (N) 485
- Dibromo-thymoquinone
- Comparison of the Inhibition of Photosynthetic Reactions in Chloroplasts by Dibromothymoquinone, Bromonitrothymol and Ioxynil 419
- Inhibition of the Nitrate Reductase Complex by Dibromothymoquinone 529
- The Effect of Analogues of Dibromothymoquinone and of Bromonitrothymol on Photosynthetic Electron Flow 831
- Dieldrin in Mammals
- Absorption, Body Distribution, Metabolism and Excretion of Dieldrin in Non-Human Primates and Other Laboratory Animals 340
- Diethyldithiocarbamate
- On the Action of Diethyldithiocarbamate as (N) 1292
- Dimer Formation
- Algal Ferredoxin-NADP⁺ Reductase with Different Molecular-Weight Forms (N) 637
- Dimeric Hemoglobin
- The Sequence of a Dimeric Hemoglobin (Erythrocytorin), Component IX, from *Chironomus thummi thummi* (Insecta Diptera) (N) 882
- Dioscorea dumetorum* Pax.
- Isolation of Batatasin I from *Dioscorea dumetorum* Rhizomes (N) 288
- Dioscoreaceae
- Isolation of Batatasin I from *Dioscorea dumetorum* Rhizomes (N) 288
- Dioxolane Ring
- Fusion of Plant Protoplasts Induced by a Positively Charged Synthetic Phospholipid 460
- 1,2-O-Dipentadecylmethylidene-glycerol-3-phosphoryl-(N-ethylamino)-ethanolamine
- Fusion of Plant Protoplasts Induced by a Positively Charged Synthetic Phospholipid 460
- Diphenylamines
- Quantitative Structure Activity Relationship of Diphenylamines as Inhibitors of Photosynthetic Electron Transport and Photophosphorylation 1024
- Dipol-Dipol-Relaxationmechanism
- Spin-Lattice-Relaxationtime-T₁ Measurements of Hyaluronic Acid 508
- Dissociation of Bentazon
- Inhibition of Photosynthesis by Bentazon in Intact Plants and Isolated Cells in Relation to the pH 944
- Dithionite
- Chemical Modification of Biliprotein Chromophores 776
- Diurnal Butterfly
- Structural Differences in the Tracheal Tapetum of Diurnal Butterflies 284
- Division of Tissue Samples
- Effect of Mechanical Traumatization on Rate

- and Constancy of Oxygen Uptake of Isolated Diaphragms 400
- T7 DNA
- Methylmercury-Induced Sedimentation Heterogeneity of T7 Bacteriophage DNA (N) 162
- DNA
- Incorporation of 5-Bromo-2-deoxyuridine into the Chloroplast DNA of *Anemia phyllitidis* 449
- DNA Content
- On the DNA Content of the Bacteroids of *Rhizobium japonicum* 793
- DNA Cross-Links
- T₂ Phage Sensitization by Linear and Angular Furocoumarins 811
- Drosophila*
- Isolation of Anatomical Brain Mutants of *Drosophila* by Histological Means 143
- The Role of Light in the Mating Behavior of *Drosophila subobscura* 1253
- Drosophila melanogaster*
- A New Mutant Affecting Aldehyde Oxidase in *Drosophila melanogaster* (N) 304
- Drug-Protein Interaction
- Drug-Protein Interaction: 8-Methoxy Psoralen as Photosensitizer of Enzymes and Amino Acids 392
- E. coli* Asparaginase
- Inhibition of *E. coli* L-Asparaginase by Reaction with 2,3-Butanedione. Chemical Modification of Arginine and Histidine Residues 742
- Ecdysone
- Investigations on the Effects of Injected Ecdysone upon the Green Shore Crab *Carcinus maenas* L. 608
- Ehrlich Ascites Tumor
- Molybdocene Dichloride as an Antitumor Agent 1174
- Effect on Photosynthetic Electron Transport
- The Effect of 2,3-Substituted Naphthoquinones on Unicellular Algae and Isolated Spinach Chloroplasts 961
- Electric Field
- The Variation of the Electrochromic Difference Spectrum at Various Stages of the Chloroplast Development 120
- Electrochromism
- The Variation of the Electrochromic Difference Spectrum at Various Stages of the Chloroplast Development 120
- Electrogenic Carrier
- Serine Transport and Membrane Depolarization in the Liverwort *Riccia fluitans* 1222
- Electromagnetic Fields
- Biological Effects of Electromagnetic Fields 616
- Electron Acceptors
- Inhibition of the Nitrate Reductase Complex by Dibromothymoquinone 529
- Electron Microscopy
- Stained Native Collagen: Interpretation of the Small Angle X-Ray Scattering and Electron Microscopic Pictures in Terms of the Primary Structure 13
- Accessibility of Extracellular Space in the Rhabdome of the Living Isolated Retina of the Crayfish 136
- Electron Microscopy of Synaptonemal Complexes in Semithin Sections (N) 299
- Electron Transport
- Mechanism of Action of the Herbicide 4,6-Dinitro-*o*-cresol in Photosynthesis 1021
- The Mode of Action of Photosystem II-Specific Inhibitors in Herbicide-Resistant Weed Biotypes 996
- Electron-Transport Inhibitor
- Differential Effects of Herbicides upon Trypsin-Treated Chloroplasts 1015
- Electronic Spectra
- Synthesis and Spectra (Electronic, CD) of the Co(I) Form of Several Natural Corrinoids 689
- Electrophoresis
- A Viscosity Model of Polyacrylamide Gel Electrophoresis 512
- Electrophysiology
- Response Characteristics and Identification of Extrinsic Mushroom Body Neurons of the Bee 612
- Electroretinogram
- Accessibility of Extracellular Space in the Rhabdome of the Living Isolated Retina of the Crayfish 136
- Element Concentrations
- Studies on the Chemistry of Lichens, XX. The Element Concentration of the Lichen Species *Alectoria fremontii* and Its Associated Bark Substrate of *Pinus silvestris* (N) 1275
- Elodea densa* Plasma Membrane
- Action of Lindane on the Current-Voltage Relationship in the Plasma Membrane of *Elodea* under Passive Conditions 1072
- Enantioselectivity of JH Carriers
- Differences in Hydrolysis and Binding of Homologous Juvenile Hormones in *Locusta migratoria* Hemolymph 588
- Enantioselectivity of JH Esterases
- Differences in Hydrolysis and Binding of Homologous Juvenile Hormones in *Locusta migratoria* Hemolymph 588
- Endocytosis
- The *in vitro* and *in vivo* Stability of the Entrapment of Methotrexate in Negatively Charged Liposomes after Sterile Filtration 114
- Enzymatic DNA Methylation
- Distribution and Enzymic Hypermethylation of Inverted DNA Repeats in Different Murine and Human Cells 558
- Enzyme
- Phenylalanyl-tRNA Synthetase from Baker-Yeast: Structural Organization of the Enzyme and Its Complex with tRNA^{Phe} as Determined by X-Ray Small-Angle Scattering 20
- Evidence for the Existence of *meta* and *para* Directing O-Methyltransferases in Tobacco Cell Cultures 46
- Enzyme Purification
- Purification and Properties of a Catechol Methyltransferase of the Yeast *Candida tropicalis* 709
- Enzyme Regulation
- Expression of Aspartokinase, Dihydrodipicolinic Acid Synthase and Homoserine Dehydrogenase During Growth of Carrot Cell Suspension Cultures on Lysine- and Threonine-Supplemented Media 1177
- Enzymology of Herbicide Detoxification
- Characterization of the Metamitron Deaminating Enzyme Activity from Sugar Beet (*Beta vulgaris* L.) Leaves 948

- Epidemic Waves
A Deterministic Model for Measles (N) . . . 647
- Eriodictyol
Eriodictyol-7-glucoside and Other Phenolics in the Blue Fruits of *Lasiacanthus japonica* (N) . . . 628
- Eriodictyol-7-glucoside
Eriodictyol-7-glucoside and Other Phenolics in the Blue Fruits of *Lasiacanthus japonica* (N) . . . 628
- ESR
On the Possible Involvement of Ascorbic Acid and Copper Proteins in Leukemia. III. ESR Investigations on the Interaction between Ascorbic Acid and Some Transition Metal Ions . . . 546
On the Possible Involvement of Ascorbic Acid and Copper Proteins in Leukemia. IV. ESR Investigations on the Interaction between Ascorbic Acid and Some Copper Proteins . . . 550
- Esterase
Sinapine Esterase. I. Characterization of Sinapine Esterase from Cotyledons of *Raphanus sativus* . . . 715
- Ethane Formation
Ethane Formation and Chlorophyll Bleaching in DCMU-Treated *Euglena gracilis* Cells and Isolated Spinach Chloroplast Lamellae . . . 1040
- Ethanethiol
Thioether Formation of Phycocyanobilin: A Model Reaction of Phycocyanin Biosynthesis . . . 192
- Ethanol Metabolism
Cultured Lung Cells: Interplay Effects of Beta-Mimetics, Prostaglandins and Corticosteroids in the Biosynthesis of Dipalmitoyl Lecithin . . . 101
- Euglena gracilis*
Cyanide Insensitive Iron Superoxide Dismutase in *Euglena gracilis* Comparison of the Reliabilities of Different Test Systems for Superoxide Dismutases . . . 374
Ethane Formation and Chlorophyll Bleaching in DCMU-Treated *Euglena gracilis* Cells and Isolated Spinach Chloroplast Lamellae . . . 1040
- Excitation-Contraction Coupling
Fine Structure and Organization of the Sarcoplasmic Reticulum in the Sino-Auricular Fibres of Frog Heart . . . 865
- Experimental Allergic Neuritis
Suppression of Experimental Allergic Neuritis with P₂ Protein of PNS Myelin (N) . . . 641
- Extra Loop
On the Dynamic Model of tRNA: Recent Experimental Findings . . . 248
- Extracellular Proteases
Osmotic Sensitivity and Tolerance and Proteinase Production in a Strain of *Saccharomyces* . . . 131
- Factorovskya*
Isoflavonoid Phytoalexins of *Parochetus communis* and *Factorovskya aschersoniana* (N) . . . 290
- Factors Influencing Activity
Catalytic Subunit of Adenosine Cyclic 3',5' Monophosphate-Dependent Protein Kinase from Rat Muscle: Basic Properties and Factors Influencing the Activity . . . 1186
- Fagaceae
On the Pigmentation of the Pollen of *Nothofagus antarctica* (Forst.) Oerst. (Fagaceae) (N) . . . 1289
- Fagopyrum esculentum*
Interference of L- α -Aminooxy- β -Phenylpropionic Acid with Phenylalanine Metabolism in Buckwheat . . . 1162
- Farinose Exudate
A Novel C-Methylated Dihydrochalcone from *Pityrogramma triangularis* var. *viscosa* (N) . . . 876
- Fate and Activity of Herbicides
Biological Determination of Photosynthetic Inhibitors in Soils and Water and Application of Bioassays to Herbicide Investigations . . . 964
- Fatty Acids
Mechanism of Paraquat Action: Inhibition of the Herbicidal Effect by a Copper Chelate with Superoxide Dismutating Activity . . . 1032
- Fern
Incorporation of 5-Bromo-2-deoxyuridine into the Chloroplast DNA of *Anemia phyllitidis* . . . 449
- Ferriporphyrins
¹⁵N-NMR Study on Complexes of Low-Spin Ferritetraphenylporphyrin . . . 1106
- Ficus carica*
The Role of 5-Hydroxymarmesin in the Biogenesis of Bergapten (N) . . . 1278
- Field Desorption Mass Spectrometry
Field Desorption Mass Spectrometry of Physiologically Active Steroid- and Dammarane-Saponins . . . 1094
- Flash Yields
Cation Effects on System II Reactions in Thylakoids: Measurements on Oxygen Evolution, the Electrochromic Change at 515 Nanometers, the Primary Acceptor and the Primary Donor . . . 826
- Flavonoids
3'-O-Methylmyricetin-3-rhamnoglucoside a New Flavonoid from the Autumnal Leaf of *Ginkgo biloba* L. (N) . . . 878
- Flavonols
Isolation and Characterization of Flavonol Converting Enzymes from *Mentha piperita* Plants and from *Mentha arvensis* Cell Suspension Cultures . . . 200
UDP-Glucose: Glucosyltransferase Activity Involved in the Biosynthesis of Flavonol Trigluco-sides in *Pisum sativum* L. Seedlings . . . 738
- Flow Cytometry
Physico-Chemical Studies of Isolated Chromatin Compared with *in situ* Chromatin after Partial Hepatectomy in the Rat . . . 442
- Fluorescence Spectroscopy
Spectroscopic and Thermodynamic Studies of Chlorophyll Containing Monolayers and Vesicles. Part II: Chlorophyll a and Pheophytin a Aggregation on DMPC Vesicles . . . 406
- Fluorochromes
Observations on the Chromatin Staining by Aluminium-Hematoxylin (N) . . . 1285
- Fluorometric Test
A Fluorometric Test for Microsomal Monooxygenase Activity in the Rat Liver with Scoparone as Substrate (N) . . . 481
- Fossil CO₂
¹³Carbon-Isotope Decrease in Annual-Rings of Twentieth-Century Trees (N) . . . 644
- Free Fatty Acids
The Chemical Composition of Cuticular Lipids from Dragonflies (Odonata) . . . 498
- Frictional Coefficient
A Viscosity Model of Polyacrylamide Gel Electrophoresis . . . 512

- Functional and Structural Organization of System-II-Electron Transport
 Studies about the Mechanism of Herbicidal Interaction with Photosystem II in Isolated Chloroplasts 1010
- Fundic Glycoproteins
In vitro Action of Gastric Mucosal Lysosomal Enzymes on Intracellular Gastric Glycoproteins 90
- Furanocoumarins
 Separation of the S-Adenosylmethionine: 5- and 8-Hydroxyfuranocoumarin O-Methyltransferases of *Ruta graveolens* L. by General Ligand Affinity Chromatography 387
- Furocoumarins
 Drug-Protein Interaction: 8-Methoxy Psoralen as Photosensitizer of Enzymes and Amino Acids
 Photosensibilization of Isolated Mesophyll Cells of *Calystegia sepium* L. 1215
- Galactolipid Synthesis
 A Possible Mechanism for a Light-Driven Regulation of the Fatty Acid Composition in Galactolipids of Chloroplasts 815
- Gallic Acid
 Gallic and Protocatechuic Acid Content during the Development of *Phycomyces blakesleanus* Bgff. 747
- Gamma-Irradiation
 Radiation Aggregates of Insulin 1139
- Gas Exchange
 The Possible Mode of Herbicidal Action of Atrazine Basing on the Gas Exchange and the Mode of Plant Damage after Treatment 923
- Gastric Ulceration
In vitro Action of Gastric Mucosal Lysosomal Enzymes on Intracellular Gastric Glycoproteins 90
- General Properties
 Catalytic Subunit of Adenosine Cyclic 3',5' Monophosphate-Dependent Protein Kinase from Rat Muscle: Basic Properties and Factors Influencing the Activity 1186
- Genetic Tablau
 On the Dynamic Model of tRNA: Recent Experimental Findings 248
- Genetics
 Osmotic Sensitivity and Tolerance and Proteinase Production in a Strain of *Saccharomyces* 131
- Geranylacetone
 Nor-Carotenoids as the Major Volatile Excretion Products of *Cyanidium* 186
- Inhibitor
 The Algal Excretion Product, Geranylacetone: A Potent Inhibitor of Carotene Biosynthesis in *Synechococcus* 957
- Geranylgeraniol
 Influence of Aminotriazol on the Biosynthesis of Chlorophyll and Phytol 1055
- Ginkgo biloba* L.
 3'-O-Methylmyricetin-3-rhamnoglucoside a New Flavonoid from the Autumnal Leaf of *Ginkgo biloba* L. (N) 878
- Glucosyltransferase
 UDP-Glucose: Glucosyltransferase Activity Involved in the Biosynthesis of Flavonol Triglycosides in *Pisum sativum* L. Seedlings 738
- Glutamine Synthetase
 Photoactive ATP Dependent Glutamine Synthetase from Chloroplasts of *Setaria italica* Beauv. 210
- Glycerol
 A Near-Infrared Spectroscopic Investigation of Water in Solutions with Proline, Glycinebetaine, Glycerol and Albumin 699
- Glycerophosphate
 Characterization of an Endogenous Transcription Inhibitor from *Physarum polycephalum* 76
- Glycosides
 3'-O-Methylmyricetin-3-rhamnoglucoside a New Flavonoid from the Autumnal Leaf of *Ginkgo biloba* L. (N) 878
- Glycosylflavonoids
 Investigations on *Hoya* Species. III. Leaf Phenolics and Latex Lipids of *Hoya lacunosa* Bl. 1125
- Green Algae
 Influence of Divalent Foreign Cations on the Uptake of Zinc by *Chlorella* 751
- Growth Control
 Density-Dependent Growth Adaptation Kinetics in 3T3 Cell Populations Following Sudden $[Ca^{2+}]$ and Temperature Changes. A Comparison with SV 40-3T3 Cells 279
- Growth Inhibition
 Density-Dependent Growth Inhibiting Interactions between 3T3 and SV 40-3T3 Cells in Mixed Cultures 272
- Growth-Regulator
 Changes of the Amounts of Pigments and Prenylquinones in Chloroplasts of *Hordeum vulgare* - Seedlings Treated with the Growth Regulating Herbicide MCPA (4-Chloro-2-methylphenoxyacetic Acid) 106
- Interpretation of Plant Growth Responses to Chemicals 931
- Gymnospermae
 3'-O-Methylmyricetin-3-rhamnoglucoside a New Flavonoid from the Autumnal Leaf of *Ginkgo biloba* L. (N) 878
- HL23V-BAB, Sequence
 Sequences Homologous to BAV Component of HL23V in Baboon Tissues 266
- Hastatoside
 Hastatosid, ein neues Iridoid aus *Verbena hastata* L. und *Verbena officinalis* L. [1] 311
- Hedya nubiferana*
 A Sex Attractant for the Green Budworm Moth, *Hedya nubiferana* 1248
- Hematoxylin
 Observations on the Chromatin Staining by Aluminium-Hematoxylin (N) 1285
- Hemoglobin
 Search for Millimeter Microwave Effects on Enzyme or Protein Functions 60
- Herbicidal Action
 Site of Action and Quantitative Structure-Activity Relationship of a Series of Herbicidal N-Aryl-Substituted 3,4-Dimethyl-2-hydroxy-5-oxo-2,5-dihydro-pyrrolones 1028
- Ethane Formation and Chlorophyll Bleaching in DCMU-Treated *Euglena gracilis* Cells and Isolated Spinach Chloroplast Lamellae 1040
- Herbicidal Action of Aminotriazol
 Influence of Aminotriazol on the Biosynthesis of Chlorophyll and Phytol 1055

- Herbicidal Action of Atrazine
The Possible Mode of Herbicidal Action of Atrazine Basing on the Gas Exchange and the Mode of Plant Damage after Treatment 923
- Herbicidal Action of Monuron
The Role of Light and Oxygen in the Action of the Photosynthetic Inhibitor Herbicide Monuron 1058
- Herbicide Action
A Review of the Place of *in vitro* Cell Culture Systems in Studies of Action, Metabolism and Resistance of Biocides Affecting Photosynthesis
- Herbicide Metabolism
A Review of the Place of *in vitro* Cell Culture Systems in Studies of Action, Metabolism and Resistance of Biocides Affecting Photosynthesis
- Herbicide Penetration
Causes of the Selective Action of the Photosynthetic Inhibitors Phenmedipham and Bentazon .
- Herbicide Resistance
A Review of the Place of *in vitro* Cell Culture Systems in Studies of Action, Metabolism and Resistance of Biocides Affecting Photosynthesis
- Herbicide Selectivity
Types of Selective Action by Herbicides which Inhibit Photosynthesis 900
- Herbicide Selectivity
Some New Results Concerning Structure-Activity Relationships of Herbicides 973
- Herbicides
Effect of Simazine on Formation of Chloroplasts Prenylipids in Seedlings of *Hordeum vulgare* L.
Comparison of the Inhibition of Photosynthetic Reactions in Chloroplasts by Dibromothymoquinone, Bromonitrothymol and Ioxynil 419
The Effect of Analogues of Dibromothymoquinone and of Bromonitrothymol on Photosynthetic Electron Flow 831
Metabolism of Chloridazon and Antipyrin in Plant Cell Suspension Cultures 914
Interpretation of Plant Growth Responses to Chemicals 931
Plant Physiological Adaptations Induced by Low Rates of Photosynthesis 932
Effect of Biocides on the Development of the Photosynthetic Apparatus of Radish Seedlings Grown under Strong and Weak Light Conditions
Biochemistry of Herbicides Affecting Photosynthesis
Inhibition of Photosynthetic Electron Flow by Phenol and Diphenylether Herbicides in Control and Trypsin-Treated Chloroplasts
The Mode of Action of Photosystem II-Specific Inhibitors in Herbicide-Resistant Weed Biotypes
Differential Effects of Herbicides upon Trypsin-Treated Chloroplasts 1015
Mechanism of Action of the Herbicide 4,6-Dinitro-*o*-cresol in Photosynthesis 1021
- Herpetriol
Herpetriol and Herpetetrol, New Lignoids Isolated from *Herpetospermum caudigerum* Wall . 1129
- Herpetospermum caudigerum*
Herpetriol and Herpetetrol, New Lignoids Isolated from *Herpetospermum caudigerum* Wall . 1129
- Herpetriol
Herpetriol and Herpetetrol, New Lignoids Isolated from *Herpetospermum caudigerum* Wall . 1129
- Heterocysts
External Factors Influencing Light-Induced Hydrogen Evolution by the Blue-Green Alga, *Nostoc muscorum* 820
- High Performance Liquid Chromatography
Screening of Aromatic Secondary Lichen Substances by High Performance Liquid Chromatography 695
- Sinapine Esterase. I. Characterization of Sinapine Esterase from Cotyledons of *Raphanus sativus* 715
- Honey Bee
Precocene II is no Anti-Juvenile Hormone in the Honey Bee, *Apis mellifera* 1261
- Hoya bella*
Investigations on *Hoya species*. II. Latex Lipids and Leaf Phenolics of *Hoya bella* Hook 5
- Hoya lacunosa*
Investigations on *Hoya species*. III. Leaf Phenolics and Latex Lipids of *Hoya lacunosa* Bl. . 1125
- Human Serum
The Influence of Spermine, Spermidine and Various Sera on T-Lymphocyte and Granulocyte Colony Growth *in vitro* 452
- Humans
Free-Running Human Circadian Rhythms in Svalbard 470
- Hyaluronicacid
Spin-Lattice-Relaxationtime- T_1 Measurements of Hyaluronic Acid 508
- 5-Hydroxymarmesin
The Role of 5-Hydroxymarmesin in the Biogenesis of Bergapten (N) 1278
- 3,17 β -Hydroxysteroid Dehydrogenase
Purification and Characterization of a 3,17 β -Hydroxysteroid Dehydrogenase from *Streptomyces hydrogenans* 533
- 17 β -Hydroxysteroid Dehydrogenase Activity
Purification and Properties of the Soluble 17 β -Hydroxysteroid Dehydrogenase of Rabbit Uterus 726
- Hypermetabolic Response
Hypermetabolic Response Induced by Juvenile Hormone Analogues in an Insect 599
- Identified Neurons
Response Characteristics and Identification of Extrinsic Mushroom Body Neurons of the Bee . 612
- Immunological Behaviour
Comparative Studies on the Dodecameric and Hexameric Forms of Yeast Aminopeptidase I . 381
- Immunological Reactivity
The Inbred Mouse Strain STU. Development and Properties (N) 306
- In vitro* Culture
An *in vitro* Culture System for Crayfish Organs . 1243
- in vitro* Transcription
Transcription and Release of RNA in Isolated Nuclei from Parsley Cells 431
- Inactivation
Types of Selective Action by Herbicides which Inhibit Photosynthesis 900
- Inbred Mice
The Inbred Mouse Strain STU. Development and Properties (N) 306

- Indicator Plants
Interpretation of Plant Growth Responses to Chemicals 931
- Inhibition
Comparison of the Inhibition of Photosynthetic Reactions in Chloroplasts by Dibromothymoquinone, Bromonitrothymol and Ioxynil 419
Inhibition of the Nitrate Reductase Complex by Dibromothymoquinone 529
Biochemistry of Herbicides Affecting Photosynthesis 966
On the Action of Diethyldithiocarbamate as Inhibitor of Copper-Zinc Superoxide Dismutase (N) 1292
- Inhibition of Photosynthesis and CO₂ Assimilation
Inhibition of Photosynthesis by Bentazon in Intact Plants and Isolated Cells in Relation to the pH 944
- Inhibition of Photosynthetic Electron Transport
Some Properties of the DCMU-Binding Site in Chloroplasts 992
- Inhibitor
Characterization of an Endogenous Transcription Inhibitor from *Physarum polycephalum* 76
A Radioactive 1,4-Benzoquinone as Inhibitor of the DBMIB-Type in Photosynthetic Electron Transport 242
The Effect of Analogues of Dibromothymoquinone and of Bromonitrothymol on Photosynthetic Electron Flow 831
The Algal Excretion Product, Geranylacetone: A Potent Inhibitor of Carotene Biosynthesis in *Synechococcus* 957
The Mode of Action of Photosystem II-Specific Inhibitors in Herbicide-Resistant Wee Biotypes
Quantitative Structure Activity Relationship of Diphenylamines as Inhibitors of Photosynthetic Electron Transport and Photophosphorylation . . 996
- Insect Eye
Structural Differences in the Tracheal Tapetum of Diurnal Butterflies 284
- Insects
Presence and Biosynthetic Implications of β,β -Carotene-2-one in the Moth *Cerura vinula* (N) . . The Sequence of a Dimeric Hemoglobin (Erythrocrucorin), Component IX, from *Chironomus thummi thummi* (Insecta Diptera) (N) . . 882
- Insulin
Radiation Aggregates of Insulin 1139
- Intact Chloroplasts
Effect of Divalent Cations on Cation Fluxes Across the Chloroplast Envelope and on Photosynthesis of Intact Chloroplasts 233
- Integument
An *in vitro* Culture System for Crayfish Organs 1243
- Interactions
Interpretation of Plant Growth Responses to Chemicals 931
- Ion Competition
Influence of Divalent Foreign Cations on the Uptake of Zinc by *Chlorella* 751
- Ion leakage
Action of Citrinin on Liposomes 397
- Ion Transport
Influence of Divalent Foreign Cations on the Uptake of Zinc by *Chlorella* 751
- β -Ionone
Nor-Carotenoids as the Major Volatile Excretion Products of *Cyanidium* 186
- Ionic Relations
Action of Lindane on the Current-Voltage Relationship in the Plasma Membrane of *Elodea* under Passive Conditions 1071
- Ioxynil
Inhibition of Photosynthetic Electron Flow by Phenol and Diphenylether Herbicides in Control and Trypsin-Treated Chloroplasts 986
- IR-Absorption Spectra
Protein Subunits of Bacteriochlorophylls B 802 and B 855 of the Light-Harvesting Complex II of *Rhodospseudomonas capsulata* 196
- Iridoid
Hastatosid, ein neues Iridoid aus *Verbena hastata* L. und *Verbena officinalis* L. [1] 311
Iridoids in *Verbena* and Some Other Verbenoideae 319
- Irradiation
Radiation Induced Loss of Anti-Ig Binding Ability of Lymphocytes (N) 888
- Isoflavans
Isoflavonoid Phytoalexins from Leaflets of *Dalbergia sericea* (N) 630
- Isoflavanone
A Revised Structure for the Phytoalexin Cajanol (N) 159
- Isoflavonoids
Isoflavonoid Phytoalexins of *Parochetus communis* and *Factorovskya aschersoniana* (N) 290
Phytoalexin Production by Species of the Genus *Caragana* (N) 293
Phytoalexin Production by Flowers of Garden Pea (*Pisum sativum*) (N) 296
Isoflavonoid Phytoalexins of Yam Bean (*Pachyrhizus erosus*) 683
- Isolated Chromatin
Physico-Chemical Studies of Isolated Chromatin Compared with *in situ* Chromatin after Partial Hepatectomy in the Rat 442
- Isolated Nuclei
Transcription and Release of RNA in Isolated Nuclei from Parsley Cells 431
- Isolated Tissues
Effect of Mechanical Traumatization on Rate and Constancy of Oxygen Uptake of Isolated Diaphragms 400
- Isotopic Dilution
Cultured Lung Cells: Effects of Isotopic Dilution and Some Undefined Stimulation on the Incorporation of Radiolabeled Palmitate and Choline into Phosphatidyl Choline (Lecithin) . . 96
- Isozymes
The Acetylcholinesterase of *Bungarus multicinctus* Venom. Purification and Properties 27
- Jacutin-Fogetten
Inhibitory Effects of the Insecticides Allethrin, Lindane, and Jacutin-Fogetten Sublimate on Photosynthetic Electron Transport 1069
- Juvenile Effect
¹³Carbon-Isotope Decrease in Annual-Rings of Twentieth-Dentury Trees (N) 644
- Juvenile Hormone I and III
Differences in Hydrolysis and Binding of Homologous Juvenile Hormones in *Locusta migratoria* Hemolymph 588

- Juvenile Hormone
Hypermetabolic Response Induced by Juvenile Hormone Analogues in an Insect 599
- Juvenoids
Hypermetabolic Response Induced by Juvenile Hormone Analogues in an Insect 599
- Kinetics
Purification, Subunit Structure, and Kinetics of the Chloroform-Released F_1 ATPase Complex from *Rhodospirillum rubrum* and Its Comparison with F_1 ATPase Forms Isolated by Other Methods 38
The Evolution of Complicated Photoreactions in Viscous Media 1264
Calculation of Yields for Photochemical Reactions (N) 1295
- β -Lactoglobulin
The Primary Structure of the β -Lactoglobulin of the Waterbuffalo (*Bubalus arnee*) (N) 880
- Lakes
Observations on the Chromatin Staining by Aluminium-Hematoxylin (N) 1285
- Lasiauthus japonica*
Eriodictyol-7-glucoside and Other Phenolics in the Blue Fruits of *Lasiauthus japonica* (N) 628
- Latex
Investigations on *Hoya species*. II. Latex Lipids and Leaf Phenolics of *Hoya bella* Hook 5
Investigations on *Hoya species*. III. Leaf Phenolics and Latex Lipids of *Hoya lacunosa* Bl. 1125
- Leaf
Investigations on *Hoya species*. II. Latex Lipids and Leaf Phenolics of *Hoya bella* Hook 5
- Leaf Wax
The Wax of *Calathea lutea* (*Marantaceae*) (N) 157
- Leguminosae
A Revised Structure for the Phytoalexin Cajanol (N) 159
Isoflavonoid Phytoalexins of *Parochetus communis* and *Factorovskya aschersoniana* (N) 290
Phytoalexin Production by Species of the Genus *Caragana* (N) 293
Phytoalexin Production by Flowers of Garden Pea (*Pisum sativum*) (N) 296
Isoflavonoid Phytoalexins from Leaflets of *Dalbergia sericea* (N) 630
Isoflavonoid Phytoalexins of Yam Bean (*Pachyrhizus erosus*) 683
- Leukemia
On the Possible Involvement of Ascorbic Acid and Copper Proteins in Leukemia. III. ESR Investigations on the Interaction between Ascorbic Acid and Some Transition Metal Ions 546
On the Possible Involvement of Ascorbic Acid and Copper Proteins in Leukemia. IV. ESR Investigations on the Interaction between Ascorbic Acid and Some Copper Proteins 550
- Lichens
Studies on the Chemistry of Lichens. XIX. New Amino Compounds from *Anaptychia fusca* and Several *Stereocaulon* Species 493
Screening of Aromatic Secondary Lichen Substances by High Performance Liquid Chromatography 695
Studies on the Chemistry of Lichens. XX. The Element Concentration of the Lichen Species
- Alectoria fremontii* and Its Associated Bark Substrate of *Pinus silvestris* 1275
- Light
The Role of Light and Oxygen in the Action of the Photosynthetic Inhibitor Herbicide Monuron 1058
Light Activation
Effect of Divalent Cations on Cation Fluxes Across the Chloroplast Envelope and on Photosynthesis of Intact Chloroplasts 233
Light Inhibition
Gallic and Protocatechuic Acid Content during the Development of *Phycomyces blakesleeanus* Bgff. 747
Light Microscopy
Accessibility of Extracellular Space in the Rhabdome of the Living Isolated Retina of the Crayfish 136
Light-Scattering
Size Distribution in the Higher Stages of Polymerization of the A-Protein of Tobacco Mosaic Virus (*vulgare*) 782
- Lindane Effects
Selective Effects of Lindane (γ -1,2,3,4,5,6 Hexachlorocyclohexane) on Photosynthesis, Membrane Transport of Amino Acids and Protein Synthesis in *Anacystis nidulans* 1062
- Lindane
Inhibitory Effects of the Insecticides Allethrin, Lindane, and Jacutin-Fogetten Sublimate on Photosynthetic Electron Transport 1070
- Lipid and Flavonoid Components
Protoplasts from Oat Primary Leaves as Tools for Experiments on the Compartmentation in Lipid and Flavonoid Metabolism 854
- Lipid Bilayers
Spectroscopic and Thermodynamic Studies of Chlorophyll Containing Monolayers and Vesicles. Part II: Chlorophyll a and Pheophytin a Aggregation on DMPC Vesicles 406
Structure of Cerebrosides. II. Small Angle X-Ray Diffraction Study of Cerasine 1121
- Lipid Peroxidation
Absence of Microsomal Lipid Peroxidation in Acatalasemic Mice (N) 301
- Lipid Peroxidation
On the Possible Involvement of Ascorbic Acid and Copper Proteins in Leukemia. IV. ESR Investigations on the Interaction between Ascorbic Acid and Some Copper Proteins 550
Ethane Formation and Chlorophyll Bleaching in DCMU-Treated *Euglena gracilis* Cells and Isolated Spinach Chloroplast Lamellae 1040
- Lipids
PYRIDAZINONES, Their Influence on the Biosynthesis of Carotenoids and the Metabolism of Lipids in Plants (Survey of Literature) 1052
Binding of Antibodies onto the Thylakoid Membrane. V. Distribution of Proteins and Lipids in the Thylakoid Membrane 1199
- Lipopolysaccharides
Structural Investigations on Lipopolysaccharides of Mutants S SF 1111 and R 595 SF 1167 of *Salmonella minnesota* 171
- Liposomes
The *in vitro* and *in vivo* Stability of the Entrapment of Methotrexate in Negatively Charged

- Liposomes after Sterile Filtration 114
 Action of Citrinin on Liposomes 397
 Liver Microsomes
 A Fluorometric Test for Microsomal Monooxygenase Activity in the Rat Liver with Scoparone as Substrate (N) 481
Locusta
 Differences in Hydrolysis and Binding of Homologous Juvenile Hormones in *Locusta migratoria* Hemolymph 588
 Long Period
 Structure of Cerebrosides. II. Small Angle X-Ray Diffraction Study of Cerasine 1121
 Lung Type II Cells
 Cultured Lung Cells: Interplay Effects of Beta-Mimetics, Prostaglandins and Corticosteroids in the Biosynthesis of Dipalmitoyl Lecithin 101
Lupinus polyphyllus
 A Model Mechanism for the Enzymatic Synthesis of Lupin Alkaloids 704
 Lymphocyte
 The Influence of Spermine, Spermidine and Various Sera on T-Lymphocyte and Granulocyte Colony Growth *in vitro* 452
 Radiation Induced Loss of Anti-Ig Binding Ability of Lymphocytes (N) 888
 Lysosomal Enzymes
 In vitro Action of Gastric Mucosal Lysosomal Enzymes on Intracellular Gastric Glycoproteins 90
 Lysosomes
 Isolation and Characterization of Vacuoles from Cell Suspension Cultures of *Daucus carota* 848
 Magnesium
 Effect of Divalent Cations on Cation Fluxes Across the Chloroplast Envelope and on Photosynthesis of Intact Chloroplasts 233
 Magnesium
 Permeability of Plasma Membrane Vesicles to Ouabain and Mg^{2+} as a Factor Determining Rate of Binding of Ouabain to Na^+ and K^+ Dependent ATPase 1224
 Magnesium Content
 γ -Irradiated Ribosomes from *Micrococcus radiodurans* in a Cell-Free Protein Synthesizing System 565
 Malate Synthase
 Incomplete Glyoxysomes Appearing at a Late Stage of Maturation of Cucumber Seeds 1232
 Malate Synthase
 Rates of *de novo* Synthesis of Malate Synthase and Albumins during the Very Early Phase of Germination 1237
Manduca sexta
 Bombykal, a Sex Pheromone of the Sphinx Moth *Manduca sexta* 9
 Marantaceae
 The Wax of *Calathea lutea* (Marantaceae) (N) 157
 Mating Success
 The Role of Light in the Mating Behavior of *Drosophila subobscura* 1253
 Measles
 A Deterministic Model for Measles (N) 647
 Mechanical Traumatization
 Effect of Mechanical Traumatization on Rate and Constancy of Oxygen Uptake of Isolated Diaphragms 400
 Mechanism of Action of Pyridazinones
 PYRIDAZINONES, Their Influence on the Biosynthesis of Carotenoids and the Metabolism of Lipids in Plants (Survey of Literature) 1052
 Mechanism of Inhibition by DCMU-Type-Herbicides
 Studies about the Mechanism of Herbicidal Interaction with Photosystem II in Isolated Chloroplasts 1010
 Melanogenesis
 Enhanced Melanization of Harding-Passey Mouse Melanoma Cells Following Treatment with Exogenous Melanosomes in Monolayer Culture 124
 Melanoma Culture
 Enhanced Melanization of Harding-Passey Mouse Melanoma Cells Following Treatment with Exogenous Melanosomes in Monolayer Culture 124
 Melanosomea
 Enhanced Melanization of Harding-Passey Mouse Melanoma Cells Following Treatment with Exogenous Melanosomes in Monolayer Culture 124
 Membrane Potential
 Action of Lindane on the Current-Voltage Relationship in the Plasma Membrane of *Elodea* under Passive Conditions 1072
 Serine Transport and Membrane Depolarization in the Liverwort *Riccia fluitans* 1222
 Membrane Transport
 Selective Effects of Lindane (γ -1,2,3,4,5,6 Hexachlorocyclohexane) on Photosynthesis, Membrane Transport of Amino Acids and Protein Synthesis in *Anacystis nidulans* 1062
Mentha arvensis
 Isolation and Characterization of Flavonol Converting Enzymes from *Mentha piperita* Plants and from *Mentha arvensis* Cell Suspension Cultures 200
Mentha piperita
 Isolation and Characterization of Flavonol Converting Enzymes from *Mentha piperita* Plants and from *Mentha arvensis* Cell Suspension Cultures 200
 Mapping
 Molecular Cloning of the Restriction Fragments Derived from Double EcoRI/PstI Digestion of the Calf Satellite I DNA and Their Restriction Analysis 1151
 Mesophyll and Bundle Sheath Chloroplasts
 Photoactive ATP Dependent Glutamine Synthetase from Chloroplasts of *Setaria italica* Beauv. 210
meta and *para* Methylation
 Evidence for the Existence of *meta* and *para* Directing O-Methyltransferases in Tobacco Cell Cultures 46
 Metabolism
 Presence and Biosynthetic Implications of β , β -Carotene-2-one in the Moth *Cerura vinula* (N) 483
 Causes of the Selective Action of the Photosynthetic Inhibitors Phenmedipham and Bentazon 926
 Zn Metabolism
 Influence of Twovalent Foreign Cations on the Uptake of Zinc by *Chlorella* 751

- Metabolism of Aromatic Compounds
Metabolism of Chloridazon and Antipyrin in Plant Cell Suspension Cultures 914
- Metabolizing Cell
Temperature-Dependence of Biological Process 474
- Metal Ions
The Influence of Different Solvents on the Interaction between Metal Ions and Tetracycline 1156
- Metal Mordanting
Observations on the Chromatin Staining by Aluminium-Hematoxylin (N) 1285
- Metallocenes
Synthesis, Biochemistry and Cytostatic Effects of N-Methyl-N- β -chloroethyl-hydrazones of Metallocene Aldehydes 670
Molybdocen-dichlorid als Antitumor-Agens 1174
- Methotrexate
The *in vitro* and *in vivo* Stability of the Entrapment of Methotrexate in Negatively Charged Liposomes after Sterile Filtration 114
- 8-Methoxy-psoralen
Drug-Protein Interaction: 8-Methoxy Psoralen as Photosensitizer of Enzymes and Amino Acids 392
- Methyl Parathion
Pesticides and Honey Bees: The Danger of Microencapsulated Formulations 153
- Methylated Dihydrochalcone
A Novel C-Methylated Dihydrochalcone from *Pityrogramma triangularis* var. *viscosa* (N) 876
- Methylheptenone
Nor-Carotenoids as the Major Volatile Excretion Products of *Cyanidium* 186
- Methylhyaluronate
Spin-Lattice-Relaxationtime- T_1 Measurements of Hyaluronic Acid 508
- Methylmercury Complexes
Methylmercury-Induced Sedimentation Heterogeneity of T7 Bacteriophage DNA (N) 162
Circular Dichroism and Ultraviolet Absorbance of Calf Thymus DNA in Presence of CH_3HgOH 259
- 3'-O-Methylmyricetin-3-rhamnoglucoside
3'-O-Methylmyricetin-3-rhamnoglucoside a New Flavonoid from the Autumnal Leaf of *Ginkgo biloba* L. (N) 878
- O-Methyltransferase
Evidence for the Existence of *meta* and *para* Directing O-Methyltransferases in Tobacco Cell Cultures 46
Separation of the S-Adenosylmethionine: 5- and 8-Hydroxyfuranocoumarin O-Methyltransferases of *Ruta graveolens* L. by General Ligand Affinity Chromatography 387
- Metribuzin
Some Properties of the DCMU-Binding Site in Chloroplasts 992
- Microbial Metabolization of Hexachlorocyclohexane
Degradation and Metabolization of Lindane and other Hexachlorocyclohexane Isomers by Anaerobic and Aerobic Soil Microorganisms 1066
- Microbodies
Incomplete Glyoxysomes Appearing at a Late Stage of Maturation of Cucumber Seeds 1232
- Micrococcus radiodurans*
 γ -Irradiated Ribosomes from *Micrococcus radiodurans* in a Cell-Free Protein Synthesizing System 565
- Microencapsulation
Pesticides and Honey Bees: The Danger of Microencapsulated Formulations 153
- Microfilaments
Complex Influence of Cytochalasin B on Actin Polymerization 555
- Microsomes
Absence of Microsomal Lipid Peroxidation in Acatalasemic Mice (N) 301
- Microwave Irradiation
Search for Millimeter Microwave Effects on Enzyme or Protein Functions 60
- Milk
The Primary Structure of the β -Lactoglobulin of the Waterbuffalo (*Bubalus arnee*) (N) 880
- Mitochondria
Temperature-Dependence of Biological Process 474
- Mode of Damage
The Possible Mode of Herbicidal Action of Atrazine Basing on the Gas Exchange and the Mode of Plant Damage after Treatment 923
- Modern Agriculture
Modern Agriculture and Herbicides 895
- Molar Ellipticity
Physico-Chemical Studies of Isolated Chromatin Compared with *in situ* Chromatin after Partial Hepatectomy in the Rat 442
- Molecular Evolution
On the Construction of a Phylogenetic Tree 478
II. On the Construction of a Phylogenetic Tree 1269
- Molecular Forms
Comparative Studies on the Dodecameric and Hexameric Forms of Yeast Aminopeptidase I 381
- Molecular Heterogeneity
Algal Ferredoxin-NADP⁺ Reductase with Different Molecular-Weight Forms (N) 637
- Molecular Sieve
A Viscosity Model of Polyacrylamide Gel Electrophoresis 512
- Molt Inhibiting Hormone
Investigations on the Effect of Injected Ecdysone upon the Green Shore Crab *Carcinus maenas* L. 608
- Molybdenum Hydroxylases
A New Mutant Affecting Aldehyde Oxidase in *Drosophila melanogaster* 304
- Molybdo-Hemeprotein
Assimilatory Nitrate Reductase of *Rhodospseudomonas capsulata* AD2: A Molybdo-Hemeprotein 33
- Molybdocene Dichloride
Molybdocen-dichlorid als Antitumor-Agens 1174
- Monoxygenases
A Fluorometric Test for Microsomal Monooxygenase Activity in the Rat Liver with Scoparone as Substrate (N) 481
- Mouse Spermatocytes
Electron Microscopy of Synaptonemal Complexes in Semithin Sections (N) 299
- Multiple Molecular Forms
Acetylcholinesterase from Bovine Erythrocytes. Purification and Properties of the Enzyme Solubilized in the Presence and the Absence of Triton X-100 721
- Muscarinic-Acetylcholinreceptor
Attempts to Enrich and to Solubilize the Mus-

- carinic Acetylcholinereceptor from Bovine Caudate nucleus 51
- Muscle
Radioactive Labelling of Lipids in Rat Neurosarcoma by Intravenous Injection of [1-¹⁴C]-Octadecenol (N) 885
- Muscle Proteins
Complex Influence of Cytochalasin B on Actin Polymerization 555
- Mushroom Bodies
Response Characteristics and Identification of Extrinsic Mushroom Body Neurons of the Bee 612
- Mushroom Poisoning
Amanitin Content and Toxicity of *Amanita ver-na* Bull.
Determination of α -, β -, and γ -Amanitin by High Performance Thin-Layer Chromatography in *Amanita phalloides* (Vaill. ex Fr.) Secr. from Various Origin 330
- Mutants
Isolation of Anatomical Brain Mutants of *Drosophila* by Histological Means 1133
- Myelin Specific Proteins
Suppression of Experimental Allergic Neuritis with P₂ Protein of PNS Myelin (N) 143
- Natural Products
Field Desorption Mass Spectrometry of Physiologically Active Steroid- and Dammarane-Saponins 1094
- Neurosarcoma
Radioactive Labelling of Lipids in Rat Neurosarcoma by Intravenous Injection of [1-¹⁴C]-Octadecenol (N) 885
- Nicotiana tabacum*
Effects of α -Aminoxy- β -phenylpropionic Acid on Phenylalanine Metabolism in *p*-Fluorophenylalanine Sensitive and Resistant Tobacco Cells 770
- Night Vision
The Physiological Optics of a Nocturnal Semi-Aquatic Spider, *Dolomedes aquaticus* (Pisauridae) 463
- Nitrate Reductase
Assimilatory Nitrate Reductase of *Rhodospseudomonas capsulata* AD?: A Molybdo-Hemeprotein 33
- Nitrate Reductase Complex
Inhibition of the Nitrate Reductase Complex by Dibromothymoquinone 529
- Nitrogen Metabolism
Plant Physiological Adaptations Induced by Low Rates of Photosynthesis 932
- Nitrogenase
External Factors Influencing Light-Induced Hydrogen Evolution by the Blue-Green Alga, *Nostoc muscorum* 820
- Nitrophenols
The Effect of Analogues of Dibromothymoquinone and of Bromonitrothymol on Photosynthetic Electron Flow 831
- ¹³C-NMR
The Incorporation of [1,2-¹³C₂] Acetate into Pisatin to Establish the Biosynthesis of Its Polyketide Moiety 87
- NMR
A ¹H NMR Study of the *Syn-Anti* Dynamic Equilibrium in Adenine Nucleosides and Nucleotides with the Aid of Some Synthetic Model Analogues with Fixed Conformations 359
Further Evidence for a S-Syn Correlation in the Purine(β)ribosides: The Solution Conformation of Two Tricyclic Analogs of Adenosine and Guanosine 653
Ribose Conformations of Adenosine Analogs Modified at the 2', 3' or 5' Positions 1075
- ¹⁵N-NMR
¹⁵N-NMR Study on Complexes of Low-Spin Ferritetraphenylporphyrin 1106
- ¹³C-NMR
The Cooperativity of the CO₂ Hb Binding: Measurements by ¹³C-NMR Spectrometry 1112
- Nodules
On the DNA Content of the Bacteroids of *Rhizobium japonicum* 793
- Nonlinear Kinetics
All-or-None Behaviour and Bistability in a Simple Cell Model with Autocatalysis of Type A + 2 B = 3 B (N) 649
- Nonthermal Effects
Biological Effects of Electromagnetic Fields 616
- nor-Carotenoid
Carotenoids of Rhizobia. III. 2',3'-trans-Dihydroxy-2-nor- β , β -carotene-3,4-dione, a Novel Carotenoid from a Mutant of *Rhizobium lupini*. Nor-Carotenoids as the Major Volatile Excretion Products of *Cyanidium* 186
- nor-N-mustard
A Theoretical Study of H₃PO₄, nor-N-Mustard, and Cyclophosphamide 658
- Nothofagus antarctica*
On the Pigmentation of the Pollen of *Nothofagus antarctica* (Forst.) Oerst. (Fagaceae) (N) 1289
- Nucleosides
Spin-Lattice-Relaxationtime *T*₁ Measurements of Nucleosides 503
- Nucleotides
Spin-Lattice-Relaxationtime *T*₁ Measurements of Nucleosides
Formation of Platinum Blues by Pyrimidine Nucleotides (N) 1287
- Numeric Integration
Calculation of Yields for Photochemical Reactions (N) 1295
- Olfaction in Tiger
Phenylethylamine as a Biochemical Marker of Tiger (N) 632
- Olfactory Receptors
A Sex Attractant for the Green Budworm Moth, *Hedya nubiferana* 1248
- Oligomycin
On the Oligomycin-Sensitivity and Subunit Composition of the ATPase Complex from *Rhodospirillum rubrum* 229
- Oncorna Viruses
The Inbred Mouse Strain STU. Development and Properties (N) 306
- Y-Organ
Investigations on the Effects of Injected Ecdysone upon the Green Shore Crab *Carcinus maenas* L. 608
- Organ-Affinity
Synthesis, Biochemistry and Cytostatic Effects of N-Methyl-N- β -chlorethyl-hydrazones of Metalloocene Aldehydes 670

- Organelle Isolation
Protoplasts from Oat Primary Leaves as Tools for Experiments on the Compartmentation in Lipid and Flavonoid Metabolism
- Organogenesis
Enrichment of *Solanum khasianum* Callus Generating Rootlets with Steroidal Glycoalkaloids (N)
- Optical Absorption
The Influence of Different Solvents on the Interaction between Metal Ions and Tetracycline
- Oscillations
Evidence for a Rapid Oxygen-Uptake in Tobacco Chloroplasts
- Osmium/*p*-Phenylenediamine
Electron Microscopy of Synaptonemal Complexes in Semithin Sections
- Osmotolerance
Osmotic Sensitivity and Tolerance and Proteinase Production in a Strain of *Saccharomyces*
- Oxygen
The Role of Light and Oxygen in the Action of the Photosynthetic Inhibitor Herbicide Monuron
- Oxygen Consumption
Effect of Mechanical Traumatization on Rate and Constancy of Oxygen Uptake of Isolated Diaphragms
- Oxygen-Evolving Side
Inhibition of Photosynthetic Electron Transport in Tobacco Chloroplasts and Thylakoids of the Blue Green Alga *Oscillatoria chalybea* by an Antiserum to Synthetic Zeaxanthin
- Oxygen Uptake
Evidence for a Rapid Oxygen-Uptake in Tobacco Chloroplasts
Characterization of a Light-Induced Oxygen-Uptake in Tobacco Protoplasts
- Pachyrrhizus*
Isoflavonoid Phytoalexins of Yam Bean (*Pachyrrhizus erosus*)
- PAPS-Sulfotransferase
A PAPS-Dependent Sulfotransferase in *Cyanophora paradoxa* Inhibited by 5'-AMP, 5'-ADP, and APS
- Paracrystalline Distortions
Structure of Cerebrosides. II. Small Angle X-Ray Diffraction Study of Cerasine
- Paraquat
Mechanism of Paraquat Action: Inhibition of the Herbicidal Effect by a Copper Chelate with Superoxide Dismutating Activity
- Parochetus*
Isoflavonoid Phytoalexins of *Parochetus communis* and *Factorovskya aschersoniana* (N)
- Partial Hepatectomy
Physico-Chemical Studies of Isolated Chromatin Compared with *in situ* Chromatin after Partial Hepatectomy in the Rat
- Peas
UDP-Glucose: Glucosyltransferase Activity Involved in the Biosynthesis of Flavonol Triglycosides in *Pisum sativum* L. Seedlings
- Penetration
Inhibition of Photosynthesis by Bentazon in Intact Plants and Isolated Cells in Relation to the pH
- PENNCAP-M
Pesticides and Honey Bees: The Danger of Microencapsulated Formulations
- Peripheral Nervous System
Suppression of Experimental Allergic Neuritis with P₂ Protein of PNS Myelin (N)
- Peroxidases
Isolation and Characterization of Flavonol Converting Enzymes from *Mentha piperita* Plants and from *Mentha arvensis* Cell Suspension Cultures
- Petroselinum crispum*
The Molecular Weight of rRNA Precursor Molecules and Their Processing in Higher Plant Cells
- Phagocytosis
Enhanced Melanization of Harding-Passey Mouse Melanoma Cells Following Treatment with Exogenous Melanosomes in Monolayer Culture
- Comparative Pharmacokinetics
Absorption, Body Distribution, Metabolism, and Excretion of Dieldrin in Non-Human Primates and Other Laboratory Animals
- Phase Change
Temperature-Dependence of Biological Process
- Phase Separation
Spectroscopic and Thermodynamic Studies of Chlorophyll Containing Monolayers and Vesicles. Part II: Chlorophyll a and Pheophytin a Aggregation on DMPC Vesicles
- Phalloidin
Determination of α -, β -, and γ -Amanitin by High Performance Thin-Layer Chromatography in *Amanita phalloides* (Vaill. ex Fr.) Secr. from Various Origin
- Phenol Herbicides
Induction of Reversible Tolerance of Algal Cells to Various Herbicides. I. Inhibition of Photosynthesis by Phenol Herbicides and Dibromothymoquinone, Its Reversal and Development of Insensitivity to Different Herbicides
- Phenolic Carboxylic Acid Derivatives
Screening of Aromatic Secondary Lichen Substances by High Performance Liquid Chromatography
- Phenols
Evidence for the Existence of *meta* and *para* Directing O-Methyltransferases in Tobacco Cell Cultures
- Phenylalanine
Effects of α -Aminoxy- β -phenylpropionic Acid on Phenylalanine Metabolism in *p*-Fluorophenylalanine Sensitive and Resistant Tobacco Cells
- Phenylalanine Ammonia-Lyase
Interference of L- α -Aminoxy- β -phenylpropionic Acid with Phenylalanine Metabolism in Buckwheat
- Phenylethylamine
Phenylethylamine as a Biochemical Marker of Tiger (N)
- Pheromones
Bombykal, a Sex Pheromone of the Sphinx Moth *Manduca sexta*
A Sex Attractant for the Green Budworm Moth, *Hedya nubiferana*

- 3'-Phosphoadenosine-5'-phosphosulfate
A PAPS-Dependent Sulfotransferase in *Cyano-
phora paradoxa* Inhibited by 5'-AMP, 5'-ADP,
and APS 222
- Photoaffinity Labels
Inhibitors of Photosynthetic Electron Trans-
port. The Properties of Diazidodialkylbenzo-
quinones 490
- Photochemistry
The Evolution of Complicated Photoreactions
in Viscous Media 1264
Calculation of Yields for Photochemical Reac-
tions (N) 1295
- Photochemotherapy
Drug-Protein Interaction: 8-Methoxy Psoralen
as Photosensitizer of Enzymes and Amino
Acids 392
- Photoinactivation of Enzymes
On the Action of Chlorosis-Inducing Herbici-
des in Leaves 1036
- Photooxidation
The Possible Mode of Herbicidal Action of
Atrazine Basing on the Gas Exchange and the
Mode of Plant Damage after Treatment 923
- Photooxidation of Chlorophyll
On the Action of Chlorosis-Inducing Herbici-
des in Leaves 1036
- Photophobic Response
Sensory Transduction in *Halobacterium halobi-
um*: Retinal Protein Pigment Controls UV-In-
duced Behavioral Response 841
- Photophosphorylation
Photoactive ATP Dependent Glutamine Synt-
hetase from Chloroplasts of *Setaria italica*
Beauv. 210
Mechanism of Action of the Herbicide 4,6-Di-
nitro-*o*-cresol in Photosynthesis 1021
- Photoproduction of Hydrogen
External Factors Influencing Light-Induced
Hydrogen Evolution by the Blue-Green Alga,
Nostoc muscorum 820
- Photoprotection by Carotenoids
Carotenoid Biosynthesis – a Target for Herbici-
de Activity 979
- Photorespiration
Characterization of a Light-Induced Oxygen-
Uptake in Tobacco Protoplasts 570
The Possible Mode of Herbicidal Action of
Atrazine Basing on the Gas Exchange and the
Mode of Plant Damage after Treatment 923
- Photosensibilization
Photosensibilization of Isolated Mesophyll
Cells of *Calystegia sepium* L. 1215
- Photosensitization of Amino Acids and Proteins
Drug-Protein Interaction: 8-Methoxy Psoralen
as Photosensitizer of Enzymes and Amino
Acids 392
- Photosynthesis
Evidence for a Rapid Oxygen-Uptake in To-
bacco Chloroplasts 414
Comparison of the Inhibition of Photosynthetic
Reactions in Chloroplasts by Dibromothymo-
quinone, Bromonitrothymol and Ioxynil 419
Cation Effects on System II Reactions in Thyla-
koids: Measurements on Oxygen Evolution, the
Electrochromic Change Measurements on Oxy-
gen Evolution, the Electrochromic Change at
515 Nanometers, the Primary Acceptor and the
Primary Donor 826
The Effect of Analogues of Dibromothymoqui-
none and of Bromonitrothymol on Photosyn-
thetic Electron Flow 831
Induction of Reversible Tolerance of Algal
Cells to Various Herbicides. I. Inhibition of
Photosynthesis by Phenol Herbicides and Di-
bromothymoquinone, Its Reversal and Devel-
opment of Insensitivity to Different Herbicides
Biochemistry of Herbicides Affecting Photo-
synthesis 951
Inhibition of Photosynthetic Electron Flow by
Phenol and Diphenylether Herbicides in Con-
trol and Trypsin-Treated Chloroplasts 986
The Mode of Action of Photosystem II-Specific
Inhibitors in Herbicide-Resistant Weed Bioty-
pes 996
Mechanism of Action of the Herbicide 4,6-Di-
nitro-*o*-cresol in Photosynthesis 1021
Selective Effects of Lindane (γ -1,2,3,4,5,6 Hexa-
chlorocyclohexane) on Photosynthesis, Mem-
brane Transport of Amino Acids and Protein
Synthesis in *Anacystis nidulans* 1062
Inhibition of Protein Synthesis in Chloroplasts
from Plant Cells by Virginiamycin 1195
Accumulation of Photoassimilatory Products by
Phycobiliprotein-Containing Algae with Spec-
ial Reference to *Cyanidium caldarium* 1209
Evidence for the Existence of Two β -Carotene
Pools and Two Biosynthetic β -Carotene Path-
ways in the Chloroplast 1205
- Photosynthesis Inhibitors
Types of Selective Action by Herbicides which
Inhibit Photosynthesis 900
Plant Physiological Adaptations Induced by
Low Rates of Photosynthesis 932
- Photosynthetic Electron Transport
A Radioactive 1,4-Benzoquinone as Inhibitor of
the DBMIB-Type in Photosynthetic Electron
Transport 242
Inhibitors of Photosynthetic Electron Trans-
port. The Properties of Diazidodialkylbenzo-
quinones (N) 490
Quantitative Structure Activity Relationship of
Diphenylamines as Inhibitors of Photosynthetic
Electron Transport and Photophosphorylation 1024
Site of Action and Quantitative Structure-Acti-
vity Relationship of a Series of Herbicidal N-
Aryl-Substituted 3,4-Dimethyl-2-hydroxy-5-
oxo-2,5-dihydro-pyrrolones 1028
Inhibitory Effects of the Insecticides Allethrin,
Lindane, and Jacutin-Fogetten Sublimate on
Photosynthetic Electron Transport 1070
- Photosynthetic Inhibitors
Biological Determination of Photosynthetic In-
hibitors in Soils and Water and Application of
Bioassays to Herbicide Investigations 964
- Photosynthetic Pigments
Interactions between Photosynthetic Pigments
Bound to Lipid and Protein Particles. Spectro-
scopic Properties 582
- Photosystem II
The Effect of Antibodies to Violaxanthin on
Photosynthetic Electron Transport 427
Cation Effects on System II Reactions in Thyla-
koids: Measurements on Oxygen Evolution, the

- Electrochromic Change at 515 Nanometers, the Primary Acceptor and the Primary Donor . . . 826
- Phototactic Reaction
- Phototactic Reactions of *Asplanchna priodonta* to Monochromatic Light . . . 148
- Phycobiliprotein-Containing Algae
- Accumulation of Photoassimilatory Products by Phycobiliprotein-Containing Algae with Special Reference to *Cyanidium caldarium* . . . 1209
- Phycocyanin
- Chemical Modification of Biliprotein Chromophores . . . 776
- The Conformation of Bilin Chromophores in Biliproteins: Ramachandran-Type Calculations
- Phycoerythrin
- The Conformation of Bilin Chromophores in Biliproteins: Ramachandran-Type Calculations
- Phycomyces blakesleeanus*
- Gallic and Protocatechuic Acid Content during the Development of *Phycomyces blakesleeanus* Bgff. . . 747
- Phylogenetic Dendrogram
- On the Construction of a Phylogenetic Tree . . 478
- II. On the Construction of a Phylogenetic Tree . 1269
- Physarum*
- Characterization of an Endogenous Transcription Inhibitor from *Physarum polycephalum* . . 76
- Physical Parameters
- Some New Results Concerning Structure-Activity Relationships of Herbicides . . . 973
- Physiologically Active Saponins
- Field Desorption Mass Spectrometry of Physiologically Active Steroid- and Dammarane-Saponins . . . 1094
- Phytoalexins
- The Incorporation of [1,2-¹³C₂] Acetate into Pisatin to Establish the Biosynthesis of Its Polyketide Moiety . . . 87
- A Revised Structure for the Phytoalexin Cajanol (N) . . . 159
- Isoflavonoid Phytoalexins of *Parochetus communis* and *Factorovskya aschersoniana* . . . 290
- Phytoalexin Production by Species of the Genus *Caragana*
- Phytoalexin Production by Flowers of Garden Pea (*Pisum sativum*) (N) . . . 293
- Isoflavonoid Phytoalexins from Leaflets of *Dalbergia sericea* (N) . . . 296
- Isoflavonoid Phytoalexins of Yam Bean (*Pachyrhizus erosus*) . . . 630
- Phytochrome
- Chemical Modification of Biliprotein Chromophores . . . 776
- The Conformation of Bilin Chromophores in Biliproteins: Ramachandran-Type Calculations
- Phytoene
- Carotenoid Biosynthesis – a Target for Herbicide Activity . . . 979
- Phytol
- Influence of Amino-triazol on the Biosynthesis of Chlorophyll and Phytol . . . 1055
- Phytotoxic Action of Naphthoquinones
- The Effect of 2,3-Substituted Naphthoquinones on Unicellular Algae and Isolated Spinach Chloroplasts . . . 961
- Pigment Orientation
- The Variation of the Electrochromic Difference Spectrum at Various stages of the Chloroplast Development . . . 120
- Pigment Synthesis
- Biochemistry of Herbicides Affecting Photosynthesis . . . 966
- Pigmentation
- On the Pigmentation of the Pollen of *Nothofagus antarctica* (Forst.) Oerst. (Fagaceae) (N) . . 1290
- Pisum*
- Phytoalexin Production by Flowers of Garden Pea (*Pisum sativum*) (N) . . . 296
- Pisum sativum*
- UDP-Glucose: Glucosyltransferase Activity Involved in the Biosynthesis of Flavonol Trigluco-sides in *Pisum sativum* L. Seedlings . . . 738
- Pityrogramma triangularis* var. *viscosa*
- A Novel C-Methylated Dihydrochalcone from *Pityrogramma triangularis* var. *viscosa* (N) . . 876
- Plant Cells
- Photosensibilization of Isolated Mesophyll Cells of *Calystegia sepium* L. . . . 1216
- Plant Growth Response
- Interpretation of Plant Growth Responses to Chemicals . . . 931
- Plant Pigments
- Mechanism of Paraquat Action: Inhibition of the Herbicidal Effect by a Copper Chelate with Superoxide Dismutating Activity . . . 1032
- The Role of Light and Oxygen in the Action of the Photosynthetic Inhibitor Herbicide Monuron . . . 1058
- Plant Suspension Cultures
- Transcription and Release of RNA in Isolated Nuclei from Parsley Cells . . . 431
- Plasma Membrane Vesicles
- Permeability of Plasma Membrane Vesicles to Ouabain and Mg²⁺ as a Factor Determining Rate of Binding of Ouabain to Na⁺ and K⁺ Dependent ATPase . . . 1224
- Plastidic Ferredoxin-NADP⁺ Reductase
- Algal Ferredoxin-NADP⁺ Reductase with Different Molecular-Weight Forms (N) . . . 637
- Platinum Blues
- Formation of Platinum Blues by Pyrimidine Nucleotides (N) . . . 1287
- Poisonous Yam
- Isolation of Batatasin I from *Dioscorea dumetorum* Rhizomes (N) . . . 288
- Pollen
- On the Pigmentation of the Pollen of *Nothofagus antarctica* (Forst.) Oerst. (Fagaceae) (N) . . 1289
- Polyacrylamide
- A Viscosity Model of Polyacrylamide Gel Electrophoresis . . . 512
- Polycations
- Protamine and Polyarginine Bacteriolysis. Similarities in Its Mechanism with Chromatin DNA Picnosis . . . 1144
- Postsynaptic Membranes
- Attempts to Enrich and to Solubilize the Muscarinic Acetylcholine Receptor from Bovine Caudate nucleus . . . 51
- Potential
- Fusion of Plant Protoplasts Induced by a Positively Charged Synthetic Phospholipid . . . 460
- Precocene II
- Precocene II is no Anti-Juvenile Hormone in the Honey Bee, *Apis mellifera* . . . 1261

- Prenylipids
Changes of the Amounts of Pigments and Prenylquinones in Chloroplasts of *Hordeum vulgare* - Seedlings Treated with the Growth Regulating Herbicide MCPA (4-Chloro-2-methylphenoxyacetic Acid) 106
Effect of Simazine on Formation of Chloroplasts Prenylipids in Seedlings of *Hordeum vulgare* L. 110
- Prey-Catching Behavior
Color Vision in Salamander Larvae (N) 890
- Primary Structure
The Primary Structure of the β -Lactoglobulin of the Waterbuffalo (*Bubalus arnee*) (N) 880
The Sequence of a Dimeric Hemoglobin (Erythrocrurin), Component IX, from *Chironomus thummi thummi* (Insecta Diptera) (N) 882
- [4-¹⁴C]Progesterone
Cardenolide Biogenesis and Translocation in *Convallaria majalis* L. 334
- Proline
A Near-Infrared Spectroscopic Investigation of Water in Solutions with Proline, Glycinebetaine, Glycerol and Albumin 699
- Properties of Trypsinated Chloroplasts
Studies about the Mechanism of Herbicidal Interaction with Photosystem II in Isolated Chloroplasts 1010
- Protein
A Near-Infrared Spectroscopic Investigation of Water in Solutions with Proline, Glycinebetaine, Glycerol and Albumin 699
- Protein Disulfide Reductase
NADPH-Dependent Thioredoxin Reductase and a New Thioredoxin from Wheat 214
- Protein Synthesis
Inhibition of Protein Synthesis in Chloroplasts from Plant Cells by Virginiamycin 1195
Rates of *de novo* Synthesis of Malate Synthase and Albumins during the Very Early Phase of Germination 1237
- Proteins
Binding of Antibodies onto the Thylakoid Membrane. V. Distribution of Proteins and Lipids in the Thylakoid Membrane 1199
- Protocatechuic Acid
Gallic and Protocatechuic Acid Content during the Development of *Phycomyces blakesleeana* Bgff. 747
- Protoplast Yield and Stability
Protoplasts from Oat Primary Leaves as Tools for Experiments on the Compartmentation in Lipid and Flavonoid Metabolism 854
- Protoplasts
Characterization of a Light-Induced Oxygen-Uptake in Tobacco Protoplasts 570
Isolation and Characterization of Vacuoles from Cell Suspension Cultures of *Daucus carota* 848
- Pseudomonas rhodos*
New C₃₀-Carotenoid Acid Glucosyl Esters from *Pseudomonas rhodos* 181
- Pteridophyta
A Novel C-Methylated Dihydrochalcone from *Pityrogramma triangularis* var. *viscosa* (N) 876
- Pterocarpan
Phytoalexin Production by Species of the Genus *Caragana* (TN) 293
Phytoalexin Production by Flowers of Garden Pea (*Pisum sativum*) (N) 296
- Isoflavonoid Phytoalexins from Leaflets of *Dalbergia sericea* (N) 630
Isoflavonoid Phytoalexins of Yam Bean (*Pachyrhizus erosus*) 683
- Pulchelloside
Iridoids in *Verbena* and Some Other Verbenaceae 319
- Pulmonary Surfactant
Cultured Lung Cells: Effects of Isotopic Dilution and Some Undefined Stimulation on the Incorporation of Radiolabeled Palmitate and Choline into Phosphatidyl Choline (Lecithin) 96
Cultured Lung Cells: Interplay Effects of Beta-Mimetics, Prostaglandins and Corticosteroids in the Biosynthesis of Dipalmitoyl Lecithin 101
- Pulse Radiolysis
Cyanide Insensitive Iron Superoxide Dismutase in *Euglena gracilis*. Comparison of the Reliabilities of Different Test Systems for Superoxide Dismutases 374
- Purine Nucleosides and Nucleotides
A ¹H NMR Study of the *Syn-Anti* Dynamic Equilibrium in Adenine Nucleosides and Nucleotides with the Aid of Some Synthetic Model Analogues with Fixed Conformations 359
- Pyrrolones
Site of Action and Quantitative Structure-Activity Relationship of a Series of Herbicidal N-Aryl-Substituted 3,4-Dimethyl-2-hydroxy-5-oxo-2,5-dihydro-pyrrolones 1028
- Quarternary and Binary Triplet Codes
Quantitative Comparison of Ribosome Binding Sites of Twelve Nucleotide Sequences from *Escherichia coli* (RNA- and DNA Phages) Based on Triplet Patterns 797
- Quinolizidine Alkaloids
A Model Mechanism for the Enzymatic Synthesis of Lupin Alkaloids 704
- Rabbit Uterus
Purification and Properties of the Soluble 17 β -Hydroxysteroid Dehydrogenase of Rabbit Uterus 726
- Radiation Aggregates
Radiation Aggregates of Insulin 1139
- γ -Radiation Resistance
 γ -Irradiated Ribosomes from *Micrococcus radiodurans* in a Cell-Free Protein Synthesizing System 565
- Radioactive 1,4-Benzoquinone
A Radioactive 1,4-Benzoquinone as Inhibitor of the DBMIB-Type in Photosynthetic Electron Transport 242
- Raphanus*
Sinapine Esterase. I. Characterization of Sinapine Esterase from Cotyledons of *Raphanus sativus* 715
- Rare Flavonoids
On the Pigmentation of the Pollen of *Nothofagus antarctica* (Forst.) Oerst. (Fagaceae) (N) 1289
- Rat Muscle
Catalytic Subunit of Adenosine Cyclic 3',5'-Monophosphate-Dependent Protein Kinase from Rat Muscle: Basic Properties and Factors Influencing the Activity 1186

- Rats
A Fluorometric Test for Microsomal Monooxygenase Activity in the Rat Liver with Scoparone as Substrate (N) 481
- Reassociation Kinetics
Distribution and Enzyme Hypermethylation of Inverted DNA Repeats in Different Murine and Human Cells 558
- Receptors
Radiation Induced Loss of Anti-Ig Binding Ability of Lymphocytes (N) 888
- Recurrent Epidemic
A Deterministic Model for Measles (N) 647
- Regulation
Effect of Simazine on Formation of Chloroplasts Prenylipids in Seedlings of *Hordeum vulgare* L. 110
- Regulation of Electron Transport
Studies about the Mechanism of Herbicidal Interaction with Photosystem II in Isolated Chloroplasts 1010
- Relative Sensitivity
Some New Results Concerning Structure-Activity Relationships of Herbicides 973
- Relative Activity
Some New Results Concerning Structure-Activity Relationships of Herbicides 973
- Resistance
The Mode of Action of Photosystem II-Specific Inhibitors in Herbicide-Resistant Weed Biotypes 996
- Respiratory Chain
Evidence for Carbon Monoxide Insensitive Respiration in the Aerobic Nitrogen Fixing Bacteria *Azotobacter vinelandii* OP and *Xanthobacter autotrophicus* GZ 29 576
- Respiratory Metabolism
Hypermetabolic Response Induced by Juvenile Hormone Analogues in an Insect 599
- Restriction
Molecular Cloning of the Restriction Fragments Derived from Double EcoRI/PstI Digestion of the Calf Satellite I DNA and Their Restriction Analysis 1151
- Extracellular Compartments
Accessibility of Extracellular Space in the Rhabdome of the Living Isolated Retina of the Crayfish 136
- Retina
Color Vision in Salamander Larvae (N) 890
- Reversal
Induction of Reversible Tolerance of Algal Cells to Various Herbicides. I. Inhibition of Photosynthesis by Phenol Herbicides and Dibromothymoquinone, Its Reversal and Development of Insensitivity to Different Herbicides 951
- Rhizobium*
On the DNA Content of the Bacteroids of *Rhizobium japonicum* 793
- Rhizobium lupini*
Carotenoids of Rhizobia. III. 2',3'-trans-Dihydroxy-2-nor- β,β -carotene-3,4-dione, a Novel Carotenoid from a Mutant of *Rhizobium lupini* 179
- Rhodopseudomonas capsulata*
Assimilatory Nitrate Reductase of *Rhodopseudomonas capsulata* AD2: A Molybdo-Hemeprotein 33
- Rhodospirillum rubrum*
Purification, Subunit Structure, and Kinetics of the Chloroform-Released F_1 ATPase Complex from *Rhodospirillum rubrum* and Its Comparison with F_1 ATPase Forms Isolated by Other Methods 38
On the Oligomycin-Sensitivity and Subunit Composition of the ATPase Complex from *Rhodospirillum rubrum* 229
- Ribonucleotide Reduction
NADPH-Dependent Thioredoxin Reductase and a New Thioredoxin from Wheat 214
- Ribosomes
PYRIDAZINONES, Their Influence on the Biosynthesis of Carotenoids and the Metabolism of Lipids in Plants (Survey of Literature) 1052
- Riccia*
Serine Transport and Membrane Depolarization in the Liverwort *Riccia fluitans* 1222
- RNA-Binding Proteins
The Role of Acidic Proteins from Cytoplasmic Fractions of Krebs II Ascites Cells for Efficient Translation 64
- RNA-DNA-Hybridization
Sequence Complexity of Transcribed Unique DNA Sequences in Genome of Mouse P815 Mastocytoma Cells 436
- RNA polymerases
Characterization of an Endogenous Transcription Inhibitor from *Physarum polycephalum* 76
- mRNA-16S rRNA Interactions
On the Dynamic Model of tRNA: Recent Experimental Findings 248
- rRNA Complexity
Sequence Complexity of Transcribed Unique DNA Sequences in Genome of Mouse P815 Mastocytoma Cells 436
- rRNA Precursor
The Molecular Weight of rRNA Precursor Molecules and Their Processing in Higher Plant Cells 253
- tRNA Base Sequences
On the Dynamic Model of tRNA: Recent Experimental Findings 248
- tRNA-rRNA Interactions
On the Dynamic Model of tRNA: Recent Experimental Findings 248
- Rotifer
Phototactic Reactions of *Asplanchna priodonta* to Monochromatic Light 148
- Ruta graveolens*
Separation of the S-Adenosylmethionine: 5- and 8-Hydroxyfuranocoumarin O-Methyltransferases of *Ruta graveolens* L. by General Ligand Affinity Chromatography 387
The Role of 5-Hydroxymarmesin in the Biogenesis of Bergapten (N) 1278
- Ruthenocen
Synthesis, Biochemistry and Cytostatic Effects of N-Methyl-N- β -chloroethyl-hydrazones of Metalloocene Aldehydes 670
- Saccharomyces
Osmotic Sensitivity and Tolerance and Proteinase Production in a Strain of Saccharomyces 131
- Salamandra salamandra*
Color Vision in Salamander Larvae (N) 890

- SAN 6706
The Effect of PS II Herbicides, Amitrol and SAN 6706 on the Activity of 3-Hydroxy-3-Methylglutaryl-Coenzyme-A-Reductase and the Incorporation of [2-¹⁴C]-Acetate and [2-³H]-Mevallionate into Chloroplast Pigments of Radish Seedlings 941
- Sarcoplasmic Reticulum
Fine Structure and Organization of the Sarcoplasmic Reticulum in the Sino-Auricular Fibres of Frog Heart 865
- Scatchard-Plot
On the Analysis of Competitive Binding of Various Ligands to Cooperative and Independent Binding Sites of Macromolecules 757
- Scattering
Phenylalanyl-tRNA Synthetase from Baker-Yeast: Structural Organization of the Enzyme and Its Complex with tRNA^{Phe} as Determined by X-Ray Small-Angle Scattering 20
- Scenedesmus acutus*
Biological Systems to Assay Herbicidal Bleaching 1044
Influence of Bleaching Herbicides on Chlorophyll and Carotenoids 1047
- Scopoletin
Eridictyol-7-glucoside and Other Phenolics in the Blue Fruits of *Lasiacanthus japonica* (N) 628
- Sedimentation Heterogeneity
Methylmercury-Induced Sedimentation Heterogeneity of T7 Bacteriophage DNA (N) 162
- Sedimentation Velocity
Size Distribution in the Higher Stages of Polymerization of the A-Protein of Tobacco Mosaic Virus (*vulgare*) 782
- Seed Ripening
Incomplete Glyoxysomes Appearing at a Late Stage of Maturation of Cucumber Seeds 1232
- Seeds
Herpetriol and Herpetetrol, New Lignoids Isolated from *Herpetospermum caudigerum* Wall 1129
- Selectivity of Phenmedipham and Bentazon
Causes of the Selective Action of the Photosynthetic Inhibitors Phenmedipham and Bentazon 926
- Semithin Sections
Electron Microscopy of Synaptonemal Complexes in Semithin Sections 299
- Senescence
Changes of the Amounts of Pigments and Prenylquinones in Chloroplasts of *Hordeum vulgare* - Seedlings Treated with the Growth Regulating Herbicide MCPA (4-Chloro-2-methylphenoxyacetic Acid) 106
- Sequence Homology
Sequences Homologous to BAV Component of HL23V in Baboon Tissues 266
- Sequencing of Underivatized Oligoglycosides
Field Desorption Mass Spectrometry of Physiologically Active Steroid- and Dammarane-Saponins 1094
- Serine
Serine Transport and Membrane Depolarization in the Liverwort *Riccia fluitans* 1222
- Serum Hormones
Cultured Lung Cells: Effects of Isotopic Dilution and Some Undefined Stimulation on the Incorporation of Radiolabeled Palmitate and Choline into Phosphatidyl Choline (Lecithin) 96
- Sex Attractant
Bombykal, a Sex Pheromone of the Sphinx Moth *Manduca sexta* 9
A Sex Attractant for the Green Budworm Moth, *Hedya nubiferana* 1248
Sex Pheromone of *Tortrix viridana*: (Z)-11-Tetradecenyl Acetate as the Main Component (N) 1281
- Sex Pheromone
Sex Pheromone of *Tortrix viridana*: (Z)-11-Tetradecenyl Acetate as the Main Component 1281
- Shade Adaptation
Plant Physiological Adaptations Induced by Low Rates of Photosynthesis 932
- Shake Incubation
Protamine and Polyarginine Bacteriolysis. Similarities in Its Mechanism with Chromatin DNA Picnosis 1144
- Shikimic Acid
Interference of L- α -Aminooxy- β -Phenylpropionic Acid with Phenylalanine Metabolism in Buckwheat 1162
- Side Effects of Lindane
Action of Lindane on the Current-Voltage Relationship in the Plasma Membrane of *Elodea* under Passive Conditions 1071
- Simazine
Effect of Simazine on Formation of Chloroplasts Prenylipids in Seedlings of *Hordeum vulgare* L. 110
- Sinapine
Sinapine Esterase. I. Characterization of Sinapine Esterase from Cotyledons of *Raphanus sativus* 715
- Single-Lens Eye
The Physiological Optics of a Nocturnal Semi-Aquatic Spider, *Dolomedes aquaticus* (Pisauridae) 463
- Singlet Oxygen
The Role of Light and Oxygen in the Action of the Photosynthetic Inhibitor Herbicide Monuron 1058
- Site of Action
Site of Action and Quantitative Structure-Activity Relationship of a Series of Herbicidal N-Aryl-Substituted 3,4-Dimethyl-2-hydroxy-5-oxo-2,5-dihydro-pyrrolones 1028
- Size Distribution
Size Distribution in the Higher Stages of Polymerization of the A-Protein of Tobacco Mosaic Virus (*vulgare*) 782
- Small Angle X-Ray Scattering
Stained Native Collagen: Interpretation of the Small Angle X-ray Scattering and Electron Microscopic Pictures in Terms of the Primary Structure 13
Phenylalanyl-tRNA Synthetase from Baker-Yeast: Structural Organization of the Enzyme and Its Complex with tRNA^{Phe} as Determined by X-Ray Small-Angle Scattering 20
Structural Investigations on Lipopolysaccharides of Mutants S SF 1111 and R 595 SF 1167 of *Salmonella minnesota* 171
- Snake Venom
The Acetylcholinesterase of *Bungarus multicinctus* Venom. Purification and Properties 27
- Sodium Incorporation
Empirical Border Lines of the Apatite Stability

- Field in the System $\text{CaO-P}_2\text{O}_5\text{-H}_2\text{O-Na}_2\text{O-CO}_2\text{-MX}$ at Room Temperature 165
- Solanum khasianum*
Enrichment of *Solanum khasianum* Callus Generating Rootlets with Steroidal Glycoalkaloids (N) 634
- Solubilization
Attempts to Enrich and to Solubilize the Muscarinic Acetylcholinereceptor from Bovine Caudate nucleus 51
- Soybean
On the DNA Content of the Bacteroids of *Rhizobium japonicum* 793
- Spacer
Immobilization of Adenosine-Acetals with Variable Alkylidene Residues - the Function of the Spacer during Enzymatic Deamination 350
- Spearman's Rank Correlation Coefficient*
Some New Results Concerning Structure-Activity Relationships of Herbicides 973
- Spectral Sensitivity
Phototactic Reactions of *Asplanchna priodonta* to Monochromatic Light 148
- Spectroscopy
Interactions between Photosynthetic Pigments Bound to Lipid and Protein Particles. Spectroscopic Properties 582
- Spermidine
The Influence of Spermine, Spermidine and Various Sera on T-Lymphocyte and Granulocyte Colony Growth *in vitro* 452
- Spermine
The Influence of Spermine, Spermidine and Various Sera on T-Lymphocyte and Granulocyte Colony Growth *in vitro* 452
- Spider
The Physiological Optics of a Nocturnal Semi-Aquatic Spider, *Dolomedes aquaticus* (Pisauridae) 463
- Spin Lattice Relaxationtime T_1
Spin-Lattice-Relaxationtime T_1 Measurements of Nucleosides 503
Spin-Lattice-Relaxationtime- T_1 Measurements of Hyaluronic Acid 508
- SR-Mitochondria Relationship
Fine Structure and Organization of the Sarcoplasmic Reticulum in the Sino-Auricular Fibres of Frog Heart 865
- Steroidal Glycoalkaloids
Enrichment of *Solanum khasianum* Callus Generating Rootlets with Steroidal Glycoalkaloids (N) 634
- Stimulation of Dark Respiration
The Effect of 2,3-Substituted Naphthoquinones on Unicellular Algae and Isolated Spinach Chloroplasts 961
- Streptomyces hydrogenans*
Purification and Characterization of a 3,17 β -Hydroxysteroid Dehydrogenase from *Streptomyces hydrogenans* 533
- Structure-Activity Relations
Site of Action and Quantitative Structure-Activity Relationship of a Series of Herbicidal N-Aryl-Substituted 3,4-Dimethyl-2-hydroxy-5-oxo-2,5-dihydro-pyrrolones 1028
- Structure Revision
A Revised Structure for the Phytoalexin Cajanol (N) 159
- 2,3-Substituted Naphthoquinones
The Effect of 2,3-Substituted Naphthoquinones on Unicellular Algae and Isolated Spinach Chloroplasts 961
- Substitution of Human Labor by Chemicals
Modern Agriculture and Herbicides 895
- Subunit Structure
Purification, Subunit Structure, and Kinetics of the Chloroform-Released F_1 ATPase Complex from *Rhodospirillum rubrum* and Its Comparison with F_1 ATPase Forms Isolated by Other Methods 38
- Subunits
On the Oligomycin-Sensitivity and Subunit Composition of the ATPase Complex from *Rhodospirillum rubrum* 229
- Sulfate Reduction
A PAPS-Dependent Sulfotransferase in *Cyanophora paradoxa* Inhibited by 5'-AMP, 5'-ADP, and APS 222
- Sulfotransferase Activation
Distribution of Thioredoxins in Cyanobacteria (N) 1272
- Sulfur Metabolism
Improved Synthesis and Rapid Isolation of Millimole Quantities of Adenylylsulfate 346
- Sulphate Uptake
Some Characteristics of Sulphate Uptake into Synaptosomes (N) 487
- Sulphated Glycoproteins
Some Characteristics of Sulphate Uptake into Synaptosomes (N) 487
- Sun-Type Chloroplast
Effect of Biocides on the Development of the Photosynthetic Apparatus of Radish Seedlings Grown under Strong and Weak Light Conditions 936
- Superoxide
Mechanism of Paraquat Action: Inhibition of the Herbicidal Effect by a Copper Chelate with Superoxide Dismutating Activity 1032
- Superoxide Dismutase
On the Action of Diethyldithiocarbamate as Inhibitor of Copper-Zinc Superoxide Dismutase (N) 1292
- Superoxide Dismutase Test Systems
Cyanide Insensitive Iron Superoxide Dismutase in *Euglena gracilis*. Comparison of the Reliabilities of Different Test Systems for Superoxide Dismutases 374
- Suspension Cultures
Effects of α -Aminoxy- β -phenylpropionic Acid on Phenylalanine Metabolism in *p*-Fluorophenylalanine Sensitive and Resistant Tobacco Cells 770
A Review of the Place of *in vitro* Cell Culture Systems in Studies of Action, Metabolism and Resistance of Biocides Affecting Photosynthesis 905
Expression of Aspartokinase, Dihydrodipicolinic Acid Synthase and Homoserine Dehydrogenase During Growth of Carrot Cell Suspension Cultures on Lysine- and Threonine-Supplemented Media 1177
- SV40-3T3 Cells
Density-Dependent Growth Inhibiting Interactions between 3T3 and SV40-3T3 Cells in Mixed Cultures 272
Density-Dependent Growth Adaptation Kinetics in 3T3 Cell Populations Following Sudden

- [Ca²⁺] and Temperature Changes. A Comparison with SV40-3T3 Cells 279
- Swimming Track and Speed
Phototactic Reactions of *Asplanchna priodonta* to Monochromatic Light 148
- Syn-Anti* Equilibrium
A ¹H NMR Study of the *Syn-Anti* Dynamic Equilibrium in Adenine Nucleosides and Nucleotides with the Aid of Some Synthetic Model Analogous with Fixed Conformations 359
- Synaptonemal Complex
Electron Microscopy of Synaptonemal Complexes in Semithin Sections 299
- Synaptosomes
Some Characteristics of Sulphate Uptake into Synaptosomes (N) 487
- Synechococcus*
The Algal Excretion Product, Geranylacetone: A Potent Inhibitor of Carotene Biosynthesis in *Synechococcus* 957
- Synthetic and Fermentation Ethanol
Comparison of the Deuterium and Carbon-13 Contents of Ethanol Obtained by Fermentation and Chemical Synthesis 1
- T₂ Phage sensitization
T₂ Phage Sensitization by Linear and Angular Furocoumarins 811
- Temperature
Density-Dependent Growth Adaptation Kinetics in 3T3 Cell Populations Following Sudden [Ca²⁺] and Temperature Changes. A Comparison with SV40-3T3 Cells 279
- Temperature Dependence
Spin-Lattice-Relaxationtime T₁ Measurements of Nucleosides 503
- Tetracycline
The Influence of Different Solvents on the Interaction between Metal Ions and Tetracycline 1156
- (Z)-11-Tetradecenyl Acetate
Sex Pheromone of *Tortrix viridana*: (Z)-11-Tetradecenyl Acetate as the Main Component 1281
- Thermal Effects
Biological Effects of Electromagnetic Fields 616
- Thermal Stability
Physico-Chemical Studies of Isolated Chromatin Compared with *in situ* Chromatin after Partial Hepatectomy in the Rat 442
- Thiobacillus denitrificans*
Improved Synthesis and Rapid Isolation of Millimole Quantities of Adenylylsulfate 346
- Thioredoxins
NADPH-Dependent Thioredoxin Reductase and a New Thioredoxin from Wheat 214
- Thioredoxin
Distribution of Thioredoxins in Cyanobacteria (N) 1272
- Thylakoid Membrane
The Effect of Antibodies to Violaxanthin on Photosynthetic Electron Transport 427
- Thylakoid Membrane Surface
Binding of Antibodies onto the Thylakoid Membrane. V. Distribution of Proteins and Lipids in the Thylakoid Membrane 1199
- Thylakoids
Cation Effects on System II Reactions in Thylakoids: Measurements on Oxygen Evolution, the Electrochromic Change at 515 Nanometers, the Primary Acceptor and the Primary Donor 826
- Tiger Pheromone
Phenylethylamine as a Biochemical Marker of Tiger (N) 632
- Tissue Catalase
Absence of Microsomal Lipid Peroxidation in Acatalasemic Mice (N) 301
- TMV-A-Protein
Size Distribution in the Higher Stages of Polymerization of the A-Protein of Tobacco Mosaic Virus (*vulgare*) 782
- Tobacco Cell Suspension Culture
Evidence for the Existence of *meta* and *para* Directing O-Methyltransferases in Tobacco Cell Cultures 46
- Tortricidae
A Sex Attractant for the Green Budworm Moth, *Hedya nubiferana* 1248
- Tortrix viridana*
Sex Pheromone of *Tortrix viridana*: (Z)-11-Tetradecenyl Acetate as the Main Component (N) 1281
- Tracheal Tapetum lucidum
Structural Differences in the Tracheal Tapetum of Diurnal Butterflies 284
- Transition Metal Ions
On the Possible Involvement of Ascorbic Acid and Copper Proteins in Leukemia. III. ESR Investigations on the Interaction between Ascorbic Acid and Some Transition Metal Ions 546
- Translocation
Cardenolide Biogenesis and Translocation in *Convallaria majalis* L. 339
- Tree-Specific Value
¹³Carbon-Isotope Decrease in Annual-Rings of Twentieth-Century Trees (N) 644
- as*-Triazinone Herbicides
Characterization of the Metamitron Deaminating Enzyme Activity from Sugar Beet (*Beta vulgaris* L.) Leaves 948
- Tricyclic Nucleosides
Further Evidence for a S-Syn Correlation in the Purine(β)ribosides: The Solution Conformation of Two Tricyclic Analogs of Adenosine and Guanosine 653
- Triglycerides
UDP-Glucose: Glucosyltransferase Activity Involved in the Biosynthesis of Flavonol Triglycerides in *Pisum sativum* L. Seedlings 738
- Triglycerides
The Chemical Composition of Cuticular Lipids from Dragonflies (Odonata) 498
- Triterpenoids
Investigations on *Hoya species*. II. Latex Lipids and Leaf Phenolics of *Hoya bella* Hook 5
- Investigations on *Hoya species*. III. Leaf Phenolics and Latex Lipids of *Hoya lacunosa* Bl. 1125
- Trypsin Degradation
Protein Subunits of Bacteriochlorophylls B 802 and B 855 of the Light-Harvesting Complex II of *Rhodospseudomonas capsulata* 196
- Trypsin Sensitivity of the DCMU Binding Site
Some Properties of the DCMU-Binding Site in Chloroplasts 992
- Trypsin Treatment
Inhibition of Photosynthetic Electron Flow by Phenol and Diphenylether Herbicides in Control and Trypsin-Treated Chloroplasts 986

- Differential Effects of Herbicides upon Trypsin-Treated Chloroplasts 1015
- Tumors
- The Inbred Mouse Strain STU. Development and Properties (N) 306
- Two- and Three-Layer Aggregates
- Size Distribution in the Higher Stages of Polymerization of the A-Protein of Tobacco Mosaic Virus (*vulgare*) 782
- Type II Cells
- Cultured Lung Cells: Effects of Isotopic Dilution and Some Undefined Stimulation on the Incorporation of Radiolabeled Palmitate and Choline into Phosphatidyl Choline (Lecithin) 96
- Ultraviolet Absorbance
- Circular Dichroism and Ultraviolet Absorbance of Calf Thymus DNA in Presence of CH₃HgOH
- 5'-UMP
- Formation of Platinum Blues by Pyrimidine Nucleotides (N) 1287
- Under-Water Vision
- The Physiological Optics of a Nocturnal Semi-Aquatic Spider, *Dolomedes aquaticus* (Pisauridae) 463
- Urine Electrolytes
- Free-Running Human Circadian Rhythms in Svalbard 470
- Vacuoles
- Isolation and Characterization of Vacuoles from Cell Suspension Cultures of *Daucus carota*
- Verbena*
- Iridoids in *Verbena* and Some Other Verbenoideae 848
- Verbena hastata*
- Hastatosid, ein neues Iridoid aus *Verbena hastata* L. und *Verbena officinalis* L. 319
- Verbena officinalis*
- Hastatosid, ein neues Iridoid aus *Verbena hastata* L. und *Verbena officinalis* L. 311
- Violaxanthin
- The Effect of Antibodies to Violaxanthin on Photosynthetic Electron Transport 427
- Viscosity
- A Viscosity Model of Polyacrylamide Gel Electrophoresis 512
- Viscous Media
- The Evolution of Complicated Photoreactions in Viscous Media 1264
- Visual Courtship Signals
- The Role of Light in the Mating Behavior of *Drosophila subobscura* 1253
- Visual Optics
- The Physiological Optics of a Nocturnal Semi-Aquatic Spider, *Dolomedes aquaticus* (Pisauridae) 463
- Vitamin B₁₂
- Synthesis and Spectra (Electronic, CD) of the Co(I) Form of Several Natural Corrinoids 689
- Water
- Temperature-Dependence of Biological Process
- A Near-Infrared Spectroscopic Investigation of Water in Solutions with Proline, Glycinebetaine, Glycerol and Albumin 699
- Waterbuffalo
- The Primary Structure of the β -Lactoglobulin of the Waterbuffalo (*Bubalus arnee*) (N) 880
- Water Photolysis
- External Factors Influencing Light-Induced Hydrogen Evolution by the Blue-Green Alga, *Nostoc muscorum* 820
- Watt Pienosis
- Protamine and Polyarginine Bacteriolysis. Similarities in Its Mechanism with Chromatin DNA Picnosis 1144
- Wave Length
- The Role of Light in the Mating Behavior of *Drosophila subobscura* 1253
- Waxes
- The Chemical Composition of Cuticular Lipids from Dragonflies (Odonata) 498
- Wheat Albumin
- NADPH-Dependent Thioredoxin Reductase and a New Thioredoxin from Wheat 214
- Wheat and Oat Seedlings
- Influence of Aminotriazol on the Biosynthesis of Chlorophyll and Phytol 1055
- Wild-Type and Mutant
- Biological Systems to Assay Herbicidal Bleaching 1044
- X-Ray
- Phenylalanyl-tRNA Synthetase from Baker-Yeast: Structural Organization of the Enzyme and Its Complex with tRNA^{Phe} as Determined by X-Ray Small Angle Scattering 20
- X-Ray Diffraction
- Structure of Cerebrosides. II. Small Angle X-Ray Diffraction Study of Cerasine 1121
- X-Ray Structure
- Potential Anticancer Agents, XI. X-Ray Structure Determination of Acantholide 677
- Xanthobacter autotrophicus*
- Evidence for Carbon Monoxide Insensitive Respiration in the Aerobic Nitrogen Fixing Bacteria *Azotobacter vinelandii* OP and *Xanthobacter autotrophicus* GZ 29 576
- Xanthophylls
- Inhibition of Photosynthetic Electron Transport in Tobacco Chloroplasts and Thylakoids of the Blue Green Alga *Oscillatoria chalybea* by an Antiserum to Synthetic Zeaxanthin 1218
- Yam
- Isolation of Batatasin I from *Dioscorea dumetorum* Rhizomes (N) 288
- Yeast
- Osmotic Sensitivity and Tolerance and Proteinase Production in a Strain of Saccharomyces 131
- Purification and Properties of a Catechol Methyltransferase of the Yeast *Candida tropicalis* 709
- Yeast Aminopeptidase I
- Comparative Studies on the Dodecameric and Hexameric Forms of Yeast Aminopeptidase I 381
- Zinc Stimulation
- Gallic and Protocatechuic Acid Content during the Development of *Phycomyces blakesleeanus* Bgff. 747

Authors Index

- Adelung, D. 608
 Aghion, J. 582
 Alef, K. 33
 Allen, N. 9
 Amrhein, N. 1162
 Antohi, St. 1144
 Arn, H. 1281
 Arntzen, Ch. J. 996

 Baas, W. J. 5, 1125
 Baccichetti, F. 811
 Bach, T. J. 941
 Backs-Hüsemann, D. 848
 Bader, K. P. 1218
 Bahl, H. 576
 Baltá-Calleja, F. J. 1121
 Baltscheffsky, M. 229
 Baluda, M. A. 266
 Barets, A. L. 865
 Barker, R. J. 153
 Barnikol, W. K. R. 1112
 Bartnik, E. 1151
 Barz, W. 200, 848
 Basu, M. K. 96, 101
 Bauer, K. 961
 Bayley, H. 490
 Beiderbeck, R. 1215
 Bentley, M. M. 304
 Bentrup, F.-W. 1222
 Benz, J. 1055
 Berlin, J. 541, 770
 Berndt, H. 576
 Bernhardt, J. 616
 Besson, E. 1125
 Bevilacqua, R. 392
 Beyer, P. 179
 Böde, H. J. 512
 Böger, P. 637, 820, 893, 1015, 1044, 1047
 Böhl, K. 143
 Boehm, Th. L. J. 436, 558
 Börner, H. 926
 Bogenschütz, H. 1281
 Bolhár-Nordenkampf, H. R. 923
 Bookjans, G. 637
 Borggreven, J. M. P. M. 165
 Bordin, F. 811
 Bosch, J. v. d. 272, 279
 Brahmachary, R. L. 632
 Branford White, Ch. J. 487
 Braunitzer, G. 880, 882
 Briantais, J.-M. 826
 Britton, G. 979
 Broda, E. 751
 Brown, S. A. 387
 Brown, S. E. 162
 Brugnoli, G. P. 1028
 Buchholz, F. 608
 Burkhard, O. 1112
 Buschmann, H. 171
 Buser, H. R. 1281
 Čačković, H. 1121
 Caporale, G. 1278

 Carllassare, F. 811
 Chopin, J. 1126
 Christen, U. 222, 1272
 Ciferri, O. 1195
 Classen-Linke, I. 136
 Clegg, M. S. 259
 Cocito, C. 1195
 Colacicco, G. 96, 101
 Colman, O. D. 299
 Cooper, B. P. 346
 Corbett, J. R. 966
 Cordell, G. A. 677
 Coulston, F. 340
 Cunningham, J. 647
 Cuno, J. 1075
 Czoppelt, Ch. 1261

 Dahm, K. H. 9
 Daig, K. 1243
 Dall'Acqua, F. 1278
 Damodaran, C. 397
 Dancker, P. 555
 Das, V. S. R. 210
 Decker, P. 649
 Demmig, B. 233
 Dencher, N. A. 841
 Devinsky, F. 485
 Dietz, V. H. 876
 Difiore, D. 120
 Dijk, J. W. E. 165
 Dinant, M. 582
 Dodge, A. D. 1032, 1058
 Doschek, E. 1253
 Dose, K. 38
 Draber, W. 831, 973
 Drahovský, D. 436, 558
 Drews, G. 196
 Driessens, F. C. M. 165
 Duchmann, H. 533
 Dudycz, L. 359
 Dutta, J. 632
 Duvert, M. 865

 Eberspächer, J. 914
 Eder, F. A. 1052
 Eibl, H. 460
 Ekse, A. T. 470
 El-Olemy, M. M. 288
 Elger, W. 726
 Elstner, E. F. 374, 1040
 Emmerich, H. 588
 Engelmann, W. 470
 Englert, G. 179, 181
 Erber, J. 612
 Ernst, A. 820
 Esterbauer, H. 503

 Farnsworth, N. R. 677
 Favre-Bonvin, J. 1129
 Fedtke, C. 932, 948
 Feick, R. 196
 Feierabend, J. 1036
 Feige, G. B. 695, 1209
 Felle, H. 1222
 Fernandez-Bermudez, S. 1121

 Flores, M. 888
 Folch, H. 888
 Follmann, H. 214
 Formanek, H. 171, 1085
 Formanek, S. 171
 Fouad, F. M. 90
 Freise, J. 114
 Frerot, B. 1248
 Frevert, J. 1232
 Frey-Schröder, G. 200
 Furtak, K. 1152

 Gagelmann, M. 1186
 Galla, H. J. 406
 Gallois, M. 1248
 Ganesan, M. G. 397
 Garrett, J. M. 387
 Geiger, H. 878
 Gellissen, G. 588
 Genzel, L. 60
 Geywitz, P. 709
 Gimmler, H. 233
 Goldammer, E. v. 1106
 Gómez, P. L. D. 157
 Goodgame, D. M. L. 1287
 Goral, K. 20
 Govindjee 826
 Gräber, P. 120
 Gregory, E. 782
 Gressel, J. 905
 Greulich, W. 550
 Großmann, H. 27, 721
 Großmann, K. 431
 Gruenwedel, D. W. 162, 259
 Grumbach, K. H. 941, 1205
 Guiotto, A. 811, 1278
 Gunawan, S. 588
 Gurel, O. 248

 Haar, F. v. d. 20
 Haas, R. 854
 Haider, K. 1066
 Hanssen, H.-P. 498
 Hartmann, Th. 704
 Hartmeyer, H. 951
 Heinz, E. 854
 Heise, K.-P. 815
 Heisenberg, M. 143
 Hertel, H. 148
 Herzog, K. H. 51
 Heßlinger, H. 726
 Hildebrand, E. 841
 Hildebrand, J. G. 9
 Hildebrandt, A. 76
 Hilgenberg, W. 747
 Hilton, J. L. 944
 Himstedt, W. 890
 Hirth, L. 782
 Hobé, J. H. 1021
 Hofmann, H. 508
 Holländer, H. 1162
 Homberg, U. 612
 Hosemann, R. 1121

 Ibrahim, R. K. 46
 Ingham, R. K. 159, 290, 293, 296, 630, 683
 Innocenti, G. 1278
 Ishikura, N. 628

 Jacob, J. 498
 Jaenicke, R. 782
 Jawali, N. 529
 Jeeves, I. 1287
 John, J. B. St. 944
 Johnsson, A. 470
 Jourdan, P. S. 738
 Jüttner, F. 186, 957

 Kalbitzer, H. R. 757
 Kaouadji, M. 1129
 Kawamura, M. 1094
 Kawasaki, T. 1094
 Kayser, H. 483
 Keilmann, F. 60
 Keith, A. B. 641
 Keller, E. 914
 Kemmerich, P. 1036
 Kerfin, W. 820
 Kilian, H.-G. 13
 Kiltz, H.-H. 1162
 Kindl, H. 1232, 1237
 Kinzel, V. 1186
 Klein, G. 192
 Kleinig, H. 179, 181
 Klemke, W. 470
 Klemme, J.-H. 33
 Kleudgen, H. K. 106, 110
 Klimke, G. 653, 1075
 Klünger, G. 751
 Klysik, J. 1151
 Knops, H. J. 831
 Köcher, H. 961
 Köhler, E. 797, 895
 Köhler, K. 64
 Köller, W. 1232, 1237
 Köpf, H. 1174
 Köpf-Maier, P. 1174
 Kokate, Ch. K. 634
 Kolde, H.-J. 880
 Komori, T. 1094
 Kopoldová, J. 1139
 Kopp, B. 334
 Kopp, H. 503, 508
 Korte, F. 340
 Krasnec, L. 485
 Kremer, B. P. 1209
 Kroll, R. 695
 Kryspin-Sørensen, I. 599
 Kubelka, W. 334
 Kübler, D. 1186
 Kufer, W. 776
 Kunert, K.-J. 1015, 1044, 1047
 Kunzmann, M. R. 153
 Kurosawa, K. 628

 Lacko, I. 485
 Lakshmanan, M. 397
 Lange, R. 546
 Lee-Kaden, J. 1062

- Lehmann-Kirk, U. 427, 1218
 Lehner, Y. 153
 Leising, H. B. 124
 Leitner, M. 1174
 Lengfelder, E. 374, 1292
 Liberatori, J. 880
 Lichtenthaler, H. K. 936
 Liefländer, M. 27, 51, 721
 Linden, W. A. 442
 Lingens, F. 914
 Link, K. 419
 Liss, E. 670
 Loboda-Čačković, J. 1121
 Löffelhardt, W. 334
 Löffler, H.-G. 381, 742
 Löffler, M. 805
 Löw, I. 555
 Lohmann, W. 546, 550, 1156
 Lotter, H. 677
 Lowitz, Th. 1036
 Lüdemann, H.-D. 653, 1075
 Lühning, H. 1222
 Luisetti, J. 406
 Lurz, G. 951
 Luuring, B. 120

 Magerstedt, P. 114
 Maier, H. 272, 279
 Malterud, K. E. 157
 Mangold, H. K. 885
 Mansell, R. L. 738
 Marcillac, G. D. de 782
 Mariotte, A.-M. 1129
 Maschler, R. 452
 Mathis, P. 826
 Matthews, B. F. 1177
 Matthies, M. 1156
 Maurer, H. R. 452
 Mauser, H. 1264, 1295
 McDermott, J. R. 641
 Meister, W. 179, 181
 Melchers, G. 460
 Mengel, R. 76, 1075
 Meyer, H. 13
 Miller, P. 442
 Milz, S. 319
 Mishra, L. 266
 Miyahara, K. 1095
 Mlynarčík, D. 485
 Möhwald, H. 406
 Moser, H. 1
 Moser, P. 1028
 Moskopidís, M. 689
 Müller, H. W. 38, 229
 Müller, W. 340
 Müller-Enoch, D. 481
 Mukherjee, K. D. 885

 Nagata, T. 460
 Nicolini, C. 442
 Niemann, G. J. 5, 1125
 Nohynek, G. 340
 Nurmman, G. 715

 Ockenfels, H. 481
 Oettmeier, W. 242, 1024

 Ojeda, F. 888
 Oorschot, J. L. P. van 900
 Ott, J. 350

 Pallett, K. E. 1058
 Panusz, H. 1151
 Payne, Th. L. 9
 Pestemer, W. 964
 Peter, M. G. 588
 Petz, D. 742
 Pfister, K. 996
 Pichotka, J. 400
 Pieber, M. 478, 1269
 Pils, I. 1040
 Pilz, I. 20
 Pinsker, W. 1253
 Pless, R. 359
 Pollow, B. 726
 Pollow, K. 726
 Popescu, A. 1144
 Postius, St. 805
 Popovici, G. 854
 Priesner, E. 1248, 1282
 Pyerin, W. 1187

 Radunz, A. 427, 1199, 1218
 Radwan, S. S. 634
 Rahmig, W. 279
 Ramakrishna, J. 529
 Rauschenbach, P. 1
 Rauscher, S. 1281
 Ravindran, K. V. 397
 Ray, A. K. 96, 101
 Reimer, S. 419, 831
 Reisch, J. 288
 Rembold, H. 1261
 Renger, G. 120, 1010
 Rensen, J. S. van 1021
 Retzlaff, G. 944
 Ribí, W. A. 284
 Richter, I. 885
 Ries, P. 1215
 Rimpler, H. 311, 319
 Robins, M. J. 1075
 Rodighiero, G. 392
 Rodighiero, P. 1278
 Röhm, K.-H. 381
 Röller, H. 9
 Rosemeyer, H. 350
 Rosenbaum, R. M. 96, 101
 Rüdiger, W. 192, 1055, 1086
 Rueß, K.-P. 51

 Sainis, J. K. 529
 Saleh, A. A. 677
 Salzer, M. 38
 Sandmann, G. 747, 1044
 Sane, P. V. 529
 Saphon, S. 826
 Sasse, F. 848
 Sauer, A. 815
 Sauer, H. W. 76
 Saygin, Ö. 649
 Schachtschabel, D. O. 124
 Schäfer, B. 311

 Schäfer, W. 306
 Schallenberg, J. 541
 Scheer, H. 776, 1086
 Schefczik, K. 1072
 Schiavon, O. 392
 Schiebel, H.-M. 704
 Schmid, G. H. 414, 427, 570, 1218
 Schmid, H.-P. 64
 Schmidt, A. 222, 1272
 Schmidt, F. W. 114
 Schmidt, H. J. 400
 Schmidt, R. R. 948
 Schmitt, R. 181
 Schmut, O. 508
 Schnarr, M. 1156
 Schneider, F. 742, 805
 Schneider, M. 670
 Schobert, B. 699
 Schraudolf, H. 449
 Schreiber, J. 550
 Schröder, W. 136
 Schulten, H.-R. 1094
 Schulz, U. 1036
 Schwulera, U. 38
 Seeger, R. 330, 1133
 Seela, F. 350
 Seigler, D. S. 876
 Seitz, Ul. 253, 431
 Seitz, Ur. 253, 431
 Setyono, B. 64
 Sharma, G. K. 1261
 Sharma, S. K. 387
 Shugar, D. 359
 Shute, J. L. 738
 Silva, M. P. de 644
 Simon, H. 1
 Simonis, W. 1062, 1072
 Skowronski, J. 1151
 Sláma, K. 599
 Smith, D. M. 876
 Solberg, Y. 493, 1275
 Sommer, I. 279
 Sommer, M. 400
 Šonka, J. 449
 Soto, M. A. 478, 1269
 Spencer, D. M. 131
 Spencer, J. F. T. 131
 Spiller, H. 820
 Spindler, K.-D. 1243
 Starratt, A. N. 9
 Steer, W. 882
 Steffen, Ch. 301
 Stehlik, D. 757
 Steinbüchl, A. 576
 Sterk, H. 503, 508
 Stichler, W. 1
 Stieve, H. 136
 Stijve, T. 330, 1133
 Stockert, J. C. 299, 1285
 Stoessl, A. 87
 Stolarski, R. 359
 Stothers, J. B. 87
 Strack, D. 695, 715
 Strotmann, H. 992
 Struble, D. L. 1281
 Süßmuth, R. 565
 Sugahara, K. 628

 Suske, G. 214
 Szymczak, G. 1151

 Tanaka, O. 1094
 Techy, F. 582
 Tempel, P. 890
 Teschner, R. 805
 Thibault, P. 414, 570
 Thomas, H. 481, 709
 Thommen, H. 181
 Tiboni, O. 1195
 Tischer, W. 992
 Tohá, J. 478, 1269
 Townsend, L. B. 653
 Träger, L. 533
 Trebst, A. 419, 831, 986, 1028
 Trincer, K. 474
 Trüper, H. G. 346
 Tsang, Y.-F. 46
 Tuengler, P. 60

 Ulmer, W. 658
 Urbach, D. 951
 Urbach, W. 951

 Vanlinden, F. 1195
 Venkataramana, S. 210
 Vernet, C. 826
 Veronese, F. M. 392
 Vesper, J. 709
 Voermann, S. 1281
 Vogel, D. 782
 Voigtländer, R. 1174
 Vollmer, B. 770
 Volm, M. 885

 Wagner, H. 677
 Wagner, W. 214
 Waldron-Edward, D. 90
 Walter, H. 1224
 Wawra, H. 171
 Wayss, K. 885
 Weber, N. 885
 Weinert, M. 27
 Weissenböck, G. 854
 Wenzel, M. 670
 Werner, D. 793
 Widholm, J. M. 1177
 Widmann, A. 565
 Wiermann, R. 1289
 Wilcockson, J. 793
 Wild, A. 1070
 Williams, D. S. 463
 Williamson, J. H. 304
 Wink, M. 704
 Wittner, M. 96, 101
 Wölfe, D. 576
 Wollenweber, E. 157, 876, 1289
 Wong, D. 826
 Wright, K. 966
 Würzer, G. 931
 Wydrzynski, Th. 826

 Yahara, S. 1094
 Youngman, R. J. 1032

The Conformation of Bilin Chromophores in Biliproteins: Ramachandran-Type Calculations

Hugo Scheer, Helmut Formanek, and Wolfhart Rüdiger

Botanisches Institut, Universität München, Menzinger Straße 67, D-8000 München 19

Z. Naturforsch. **34 c**, 1085–1093 (1979); received June 29, 1979

Bilin Conformation, Phycocyanin, Phycoerythrin, Phytochrome

Ramachandran-type calculations are performed for conformations of bilin chromophores present in the biliproteins phycocyanin, phycoerythrin and phytochrome. The atomic coordinates are taken from x-ray data of crystalline model compounds, namely biliverdin for pyrrole rings B, C, D and substituted succinimides for the hydrogenated ring A including a thioether containing β -substituent. Maxima and minima for steric hindrance are calculated for rotation of the thioether side chain, the rotation of pyrrole rings at single bonds (*syn-anti*-forms) and at double bonds (*Z-E*-isomers) of the methine bridges. Whereas quasi-planar structures are possible for all *syn*, *Z*-forms, only twisted structures are possible if *anti*, *E*-forms are considered. The relevance for the bilin conformations of native biliproteins and of the $P_r \rightleftharpoons P_{fr}$ phototransformation is discussed.

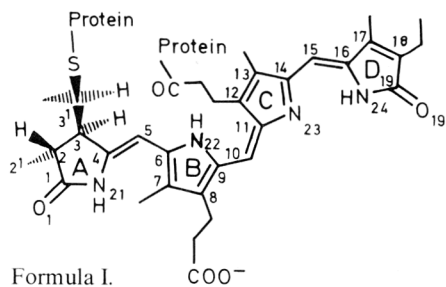
Bilins (contrary to most porphyrins) are flexible molecules. A great number of conformations can theoretically be drawn which arise from rotation around single bonds of methene bridges (Fig. 1). The shape of the molecule ranges from cyclic porphyrin-like to maximally opened (stretched) forms. Similar forms can be induced by *Z-E* isomerization of double bonds of methine bridges.

Porphyrin like forms (*i. e.* all-*Z* configuration, all-*syn* conformation) have been advanced for crystalline biliverdins [1, 2] and for biliverdins in solution [3, 4]. The only other bilindiones so far investigated are *E*, *Z*, *Z* bilindiones [5, 6] for which the *syn*, *syn*, *syn* conformation has been postulated on the basis of UV-visible spectral data [7].

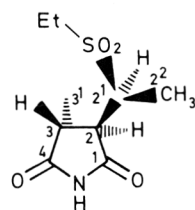
The particular spectral properties of the bilindione chromophores of native biliproteins have been explained by extended chromophore conformations (*viz.* Formula I) induced by the protein. In the case of phytochrome, experimental spectral data were compared with calculated spectral data [8]. In the

case of phycocyanin, unfolding and refolding of the biliprotein proved the reversibility of the spectral changes which again were compared with spectral data from the literature calculated for various chromophore conformations [9]. Such calculations exist for a great number of assumed bilin conformations [10–13]. However, a great deal if not most of the assumed conformations are impossible in biliproteins because of steric hindrance of the β -pyrrolic side chains. This is especially true for planar structures [8, 12] but even where non-planar-structures were considered [7, 13] arbitrary torsional angles have been introduced for the purpose of fitting of spectral data without a systematic consideration of steric hindrance.

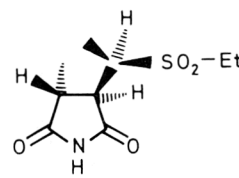
The elucidation of the stereochemistry of the side chain of ring A including the thioether linkage to the protein (Formula I) in phytochrome [14] and phycocyanin [15] together with x-ray crystallographic data of the model compounds II and III ([16], Lotter, Klein, Rüdiger in preparation) prompted us to calculate atomic distances and energy levels for conformations produced by rotations around the single and double bonds connecting the individual pyrrolic rings.



Formula I.



Formula II.



Formula III.

Reprint requests to Dr. H. Scheer.

0341-0382/79/1200-1085 \$ 01.00/0

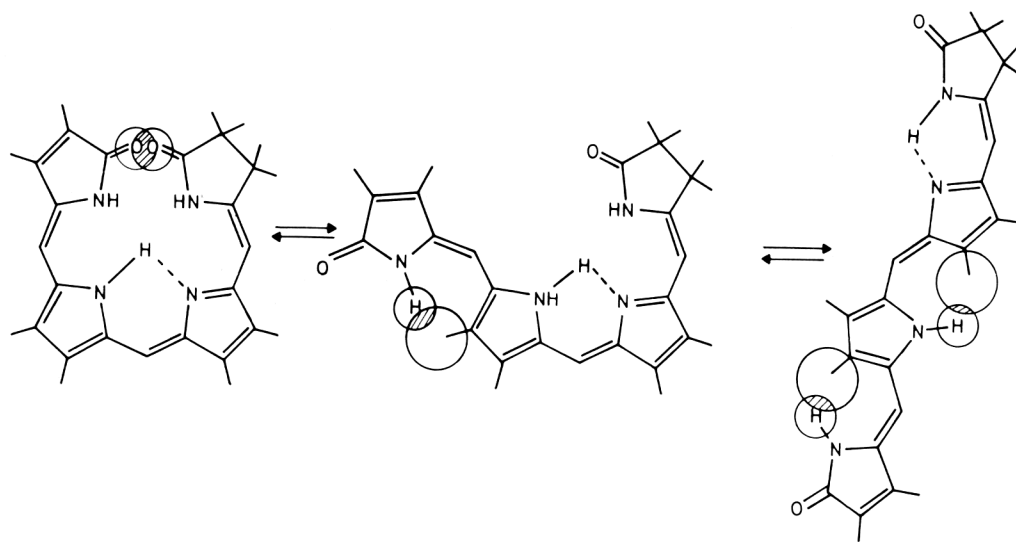


Fig. 1. Schematic representation of different arrangements of the chromophores of **I** accessible by rotations around the C-10,11 and C-14,15 single bonds (from ref. [25]).

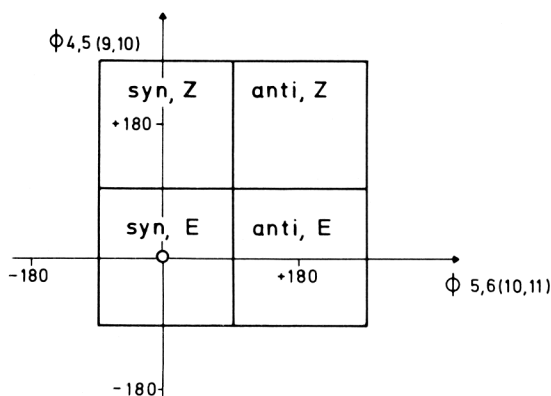


Fig. 2. Definition of the four basic forms of partial structures **IV** and **V**. Only the central part of each quadrant allows π -overlap sufficient for conjugation of the two rings. The planar structures for each form are shown in Figs 3 and 4.

Methods

The atomic coordinates for the saturated ring A of biliprotein chromophores have been taken from the succinimide **II** [16] and for the unsaturated rings from biliverdin-dimethylester [1]. They have been transformed into a rectangular coordinate system in such a way, that the N-atoms occupy the zero position, one C-atom lies in the X-axis and another C-atom in the X, Y-plane (Table I).

The atomic coordinates corresponding to conformations of different torsion angles have been calcu-

lated with a computer program using rotation matrices. The zero position of the φ -angles of partial structures **IV** and **V** are shown in Figs 3 and 4. The rotations have been performed counter clockwise viewing from C_5 or C_{10} to the rings. In the zero position of the angle τ (Fig. 5) of the thio-substituted side chain (Formula **I** – **III**), the atoms C_2 , C_3 , C_{31} and S are in one plane and the S-atom has a *syn*-position to C_2 . The rotations have been performed counter clockwise viewing from C_3 to C_{31} .

The energies corresponding to the different conformations have been calculated with the Kitaigorodskii function [17], where the interaction energy E between two non-bonded atoms is expressed as a function of a single variable z .

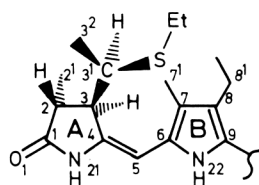
$$E = 3.5 \left(-0.04/z^6 + 8.6 \times 10^3 \exp(-13z) \right)$$

$$z = r_{ij}/r_0$$

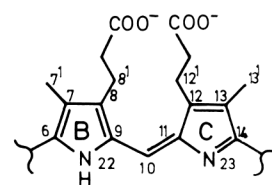
r_{ij} = distance between two non-bonded atoms

r_0 = van der Waals distance between non-bonded atoms.

The van der Waals distances are shown in Table II.



Formula IV.



Formula V.

Table I. Atomic coordinates for the Succinimide **II** and the four five-membered rings of biliverdin dimethylester. The data from refs. [16] and [1], respectively, are transformed as described in "methods".

Succinimide II			Biliverdin-dimethylester							
N ₂₁	0.00		N ₂₁	0.00	N ₂₂	0.00	N ₂₃	0.00	N ₂₄	0.00
	0.00	0.00		0.00		0.00		0.00		
	0.00	0.00		0.00		0.00		0.00		
C ₄	1.37		C ₄	1.40	C ₉	1.37	C ₁₁	1.43	C ₁₆	1.35
	0.00	0.00		0.00		0.00		0.00		
	0.00	0.00		0.00		0.00		0.00		
C ₃	1.85		C ₃	1.83	C ₈	1.77	C ₁₂	1.89	C ₁₇	1.79
	1.45	1.43		1.35		1.35		1.44		
	0.00	0.00		0.00		0.00		0.00		
C ₂	0.60		C ₂	0.69	C ₇	0.64	C ₁₃	—	C ₁₈	0.66
	2.31	2.17		2.16		—		2.20		
	0.06	0.04		0.04		—		0.00		
C ₁	−0.53		C ₁	−0.45	C ₆	−0.45	C ₁₄	−0.34	C ₁₉	−0.51
	1.26	1.29		1.24		1.28		1.28		
	0.06	−0.03		0.03		0.04		0.00		
C ₃ l	2.91		C ₃ l	3.24	C ₈ l	3.23	C ₁₂ l	3.08	C ₁₇ l	3.22
	1.57	1.83		1.86		2.03		1.83		
	1.14	−0.01		0.00		−0.14		−0.04		
C ₂ l	0.45		C ₂ l	0.59	C ₇ l	0.59	C ₁₃ l	0.76	C ₁₈ l	0.46
	3.31	3.66		3.56		3.60		3.66		
	−1.07	0.14		0.04		0.10		0.00		
O _{onC₄}	2.08		C ₅	2.21	C ₁₀	2.15	C ₁₀	2.17	C ₁₅	2.14
	−0.98	−1.09		−1.13		−1.17		−1.09		
	0.03	0.10		−0.01		0.08		−0.07		
O _{onC₁}	−1.73		O _{onC₁}	−1.65	C ₅	−1.85	C ₁₅	−1.69	O _{onC₁₉}	−1.68
	1.55	1.59		1.68		1.72		1.60		
	0.06	−0.10		0.19		0.09		0.07		

Table II. Van der Waals distances used in the calculations.

	C	N	O	S
C	3.2	2.9	2.8	3.4
N		2.7	2.7	3.2
O			2.7	3.2

Results and Discussion

Biliproteins are characterized by a hydrogenated ring A linked via a thioester bond to the protein (Formula **I**) [18, 19]. The steric factors involved in the topology control of biliproteins involve, therefore, interactions between a hydrogenated and an unsaturated ring (partial structure **IV**) as well as interactions between unsaturated rings (partial structure **V**). The bond angles and lengths for the partial structure **V** have been taken from the central methine bridge of biliverdin dimethylester (rings B and C) as determined by the *x*-ray analysis of Sheldrick [1]. The bond lengths of the partial structure **IV** are derived from a composite of two structures: ring B is

again derived from biliverdin dimethylester [1], while ring A has been replaced by a dihydro-structure taken from the *x*-ray study of 2-(2'-sulfonyl-ethyl) ethyl succinimide (**II**) [16]. The C₂l-S distance of 1.83 Å in this sulfone is comparable to the C-S distance of 1.80 Å in the thioether, methionine [20].

To take into account the inverted stereochemistry at C₃l in biliproteins, two substituents have been interchanged at (the corresponding) C₂l in the succinimide **II**. The *x*-ray structure of the corresponding epimer **III** has been solved after completion of this work (Lotter, Klein, Rüdiger in preparation). There is a good agreement of the conformation of **III** in the crystal and the one predicted from these calculations.

We consider here only the sterical interaction of vicinal pyrrole rings because there is no interaction of rings A and C or B and D. Furthermore, interaction of rings A and D occurs only if the tetrapyrrole system is in a planar or nearly planar cyclic form. A small deviation from planarity (all φ 's = 10 – 20 °) allows the system to avoid this sterical hindrance

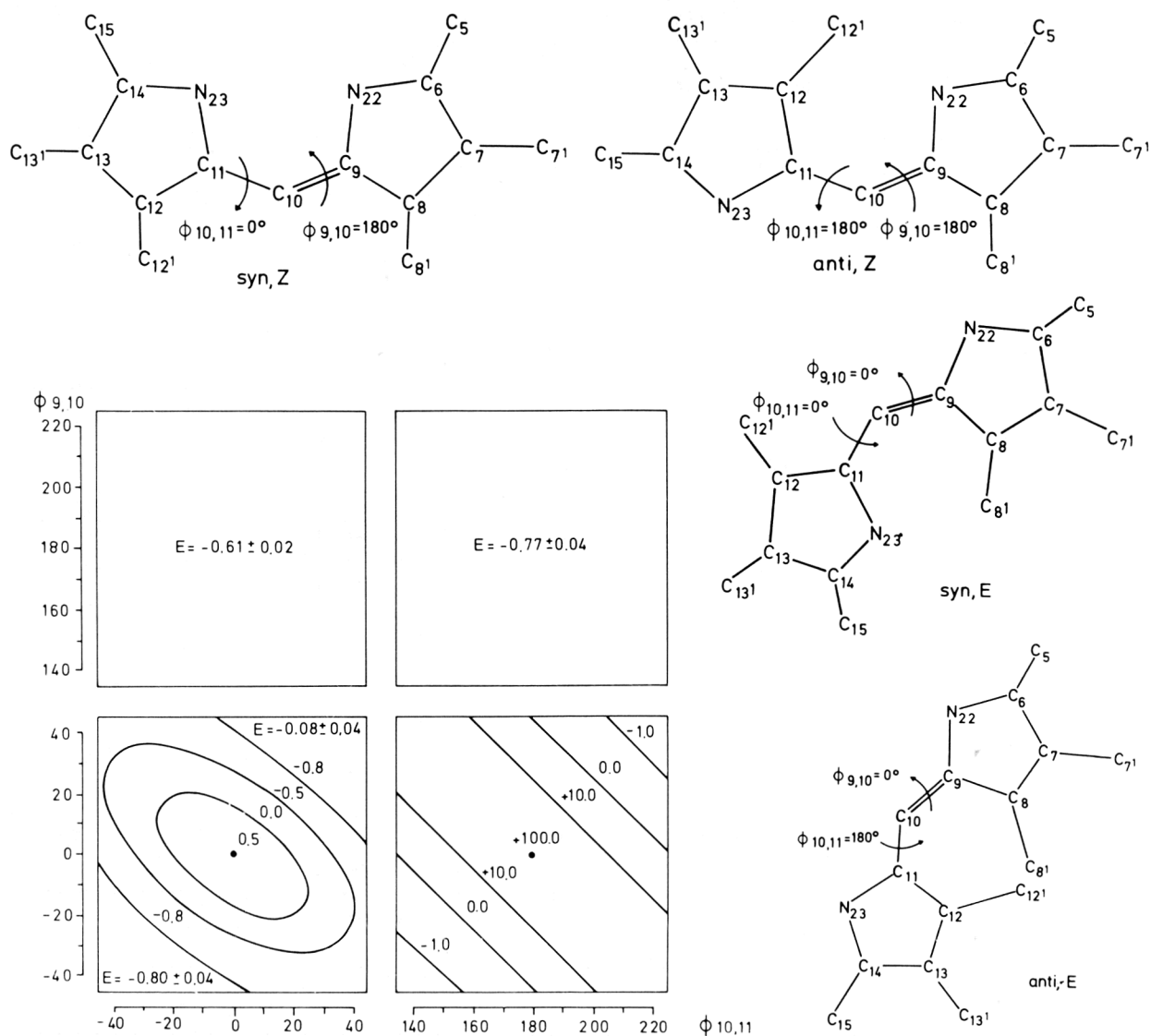


Fig. 3. Energy profiles (in kcal/mol) for the four basic forms of partial structure **V** representing the ring B, C junction in biliproteins. Only the central part of each quadrant with deviations from planarity $\leq 40^\circ$ is shown, corresponding to conjugation between the two rings.

without a major loss of π -overlap. This gives the well-known helical geometry of biliverdins [1–4].

Ramachandran-type calculations take into account only steric interactions. They thus define sterically forbidden areas and are complementary to considerations regarding H-bonds and π -system interactions, which define allowed or favorable conformations or configurations. In the case of bile pigments, steric hindrance is also complementary in its effects to H-bonding and π -interactions, as the co-

planar structures favored by the latter are sterically unfavorable.

In the formalism used throughout, the two dimensional space defined by rotations about the bridging bonds C₄, C₅ and C₅, C₆ in **IV**, and C₉, C₁₀ and C₁₀, C₁₁ in **V**, respectively, is divided into four quadrants as defined in Fig. 2. The planar structures of the four forms are shown in Figs 3 and 4. Whereas coplanarity is possible for partial structure **V** in the Z configuration (Fig. 3, upper part), steric hindrance

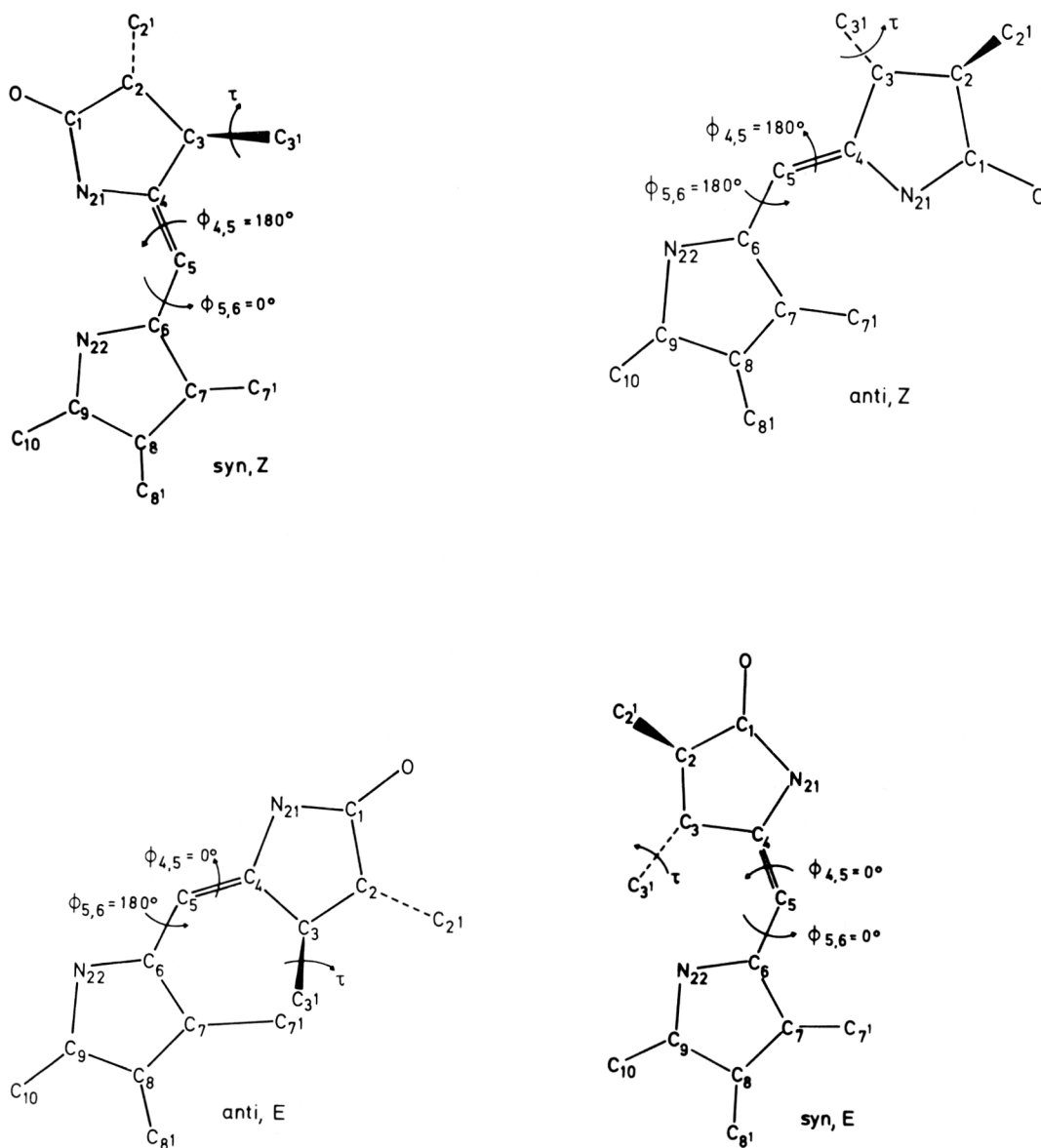


Fig. 4. Coplanar structures of the four basic forms of partial structure **IV**.

is observed in the *E* configured system (Fig. 3, lower part). No planar structure is allowed in this case. If the C-9,10 double bond is taken to be planar (*i. e.* $\phi_{9,10} = 180^\circ$) the torsion angle $\phi_{10,11}$ must be $+40^\circ$ or -40° (*anti* conformation) or $>200^\circ$ or $<160^\circ$ (*syn* conformation). The angles could be somewhat reduced if the double bond is also twisted (see Fig. 3, lower part).

Such a strongly twisted structure has been found in the as yet only crystal structure of an *anti, Z-syn-Z*, *syn-Z* bilin [21] and is also proposed for the *E*-isomers of bilindiones [7].

Steric interactions are rather pronounced in the partial structure **IV** as a model for rings A and B in biliprotein chromophores (Fig. 5). In addition to rotations around the two bridging bonds (C₄, C₅ and

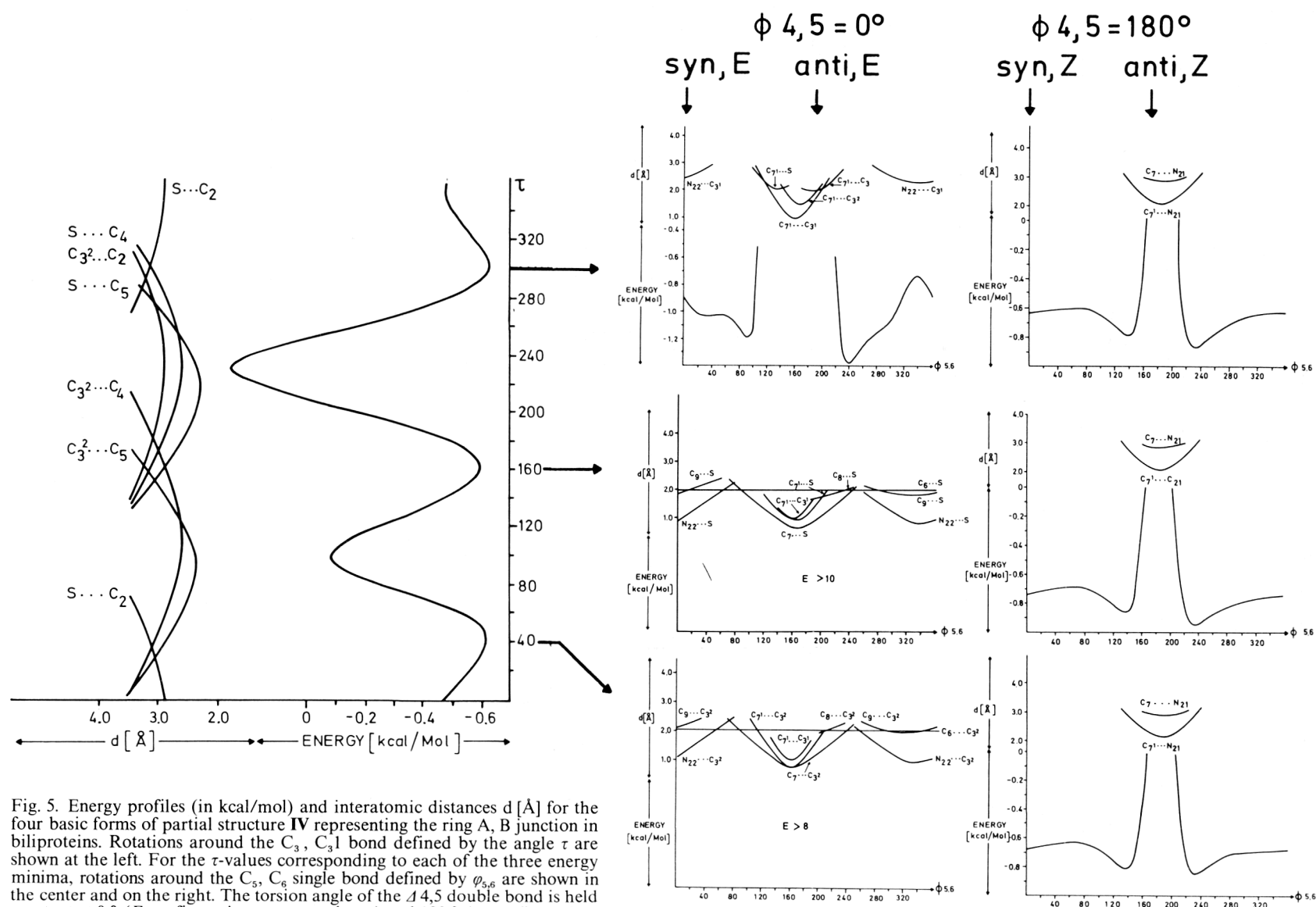


Fig. 5. Energy profiles (in kcal/mol) and interatomic distances d [Å] for the four basic forms of partial structure **IV** representing the ring A, B junction in biliproteins. Rotations around the C_3, C_{31} bond defined by the angle τ are shown at the left. For the τ -values corresponding to each of the three energy minima, rotations around the C_5, C_6 single bond defined by $\phi_{5,6}$ are shown in the center and on the right. The torsion angle of the $\Delta 4,5$ double bond is held constant at 0° (E-configurations, center column) and 180° (Z-configurations, right column).

C₅, C₆), rotations around the C₃, C₃1 bond strongly influence the stability of **IV**. The latter rotation has three minima, defined by interactions of the C₃ substituents with C₂, C₄ and C₅, which are essentially independent of the conformations at the methine bridge (Fig. 5). These minima are separated by maxima, of which at least one ($\tau \approx 225^\circ$) is above the thermal energy at ambient temperature. E-configurations of the Δ 4,5-double bond are restricted to only one of the minima ($\tau \approx 300^\circ$), which is, incidentally, the τ -value observed in the recent x-ray analysis of the C₂1-epimer **III** of the sulfone **II** (Lotter, Klein, Rüdiger in preparation). Only an extremely twisted *anti*, *E* form is sterically allowed in this case ($\varphi_{5,6} \approx 220^\circ$), and the energy minimum for the *syn*, *E* form is at a twisted conformation, too ($\varphi_{5,6} \approx 30^\circ$).

For the *Z*-configuration at the Δ 4,5-double bond, the restrictions imposed by τ are less stringent, but still pronounced. Coplanar conformations of the *anti*, *Z* form are forbidden for each τ -minimum, and the absolute minima are highly twisted *anti*, *Z* conformations in each case. These minima are close to out-of-plane angles of $\pm 40^\circ$ (corresponding to $180 \pm 40^\circ$ in Fig. 5), the limiting angle for π -interactions. A balance between π -interactions and steric hindrance can, therefore, be expected.

The asymmetric C-atoms at ring A induce a pronounced asymmetry of the steric interactions. Not only are out-of-plane angles with minimum interactions different for the two different orientations, but the minima have also different energy. As an example, the minima for the *anti*, *E* form ($\tau = 300^\circ$) are at $\varphi_{5,6} = 90^\circ$ and 240° , respectively, with an energy difference $\Delta H = 0.2$ kcal/mol and for the *anti*, *Z* form at $\varphi_{5,6} = 140^\circ$ and 235° ($\Delta H = 0.1$ kcal/mol). These population differences may even be enhanced by electronic factors, *e.g.* only the minimum at $\varphi_{5,6} = 140^\circ$ would be sufficient for a conjugation of the Δ 4,5 bond with the remaining π -system. Even disregarding the latter, these energy differences lead to preferential populations of one chiral conformer by a factor of 1.38 and 1.18, respectively, and similar population differences can be expected for other basic forms. In the helical topologies typical for bilindiones, all methine bridges are twisted in the same absolute sense, and hence the preference of one helicity should be in the same range. From the known 2R, 3R, 3¹R-configuration of phycocyanin (**Ia**), allophycocyanin (**Ib**), and P_r (**Ic**), an M-helix is expect-

ed*. It should be noted, however, that in the phycoerythrin-chromophore the effect of the 16R configuration [22, 23] would counteract the former effect. The cooperative twisting applies to the cyclic *all-syn*, *Z* forms of the chromophore only, but not to open forms. Here, the twist as the C₅ methine bridge does not necessarily propagate to the other two bridges. The CD-signals of the chromophores of native biliproteins containing extended chromophores is indicative, however, of a similar twist at all three methine bridges.

The stability of planar conformations of partial structure **V** decreases in the order *anti*, *Z* \geq *syn*, *Z* $>$ *syn*, *E* $>$ *anti*, *E*. This difference in stability can be diminished however if the methine bridge is strongly twisted. The predominance of all-*syn*, *Z* conformations of bilindiones observed up to now is, therefore, due to the combined action of steric hindrance between neighboring rings and forces which drive the system towards coplanarity like π -interactions and H-bonds.

A noteworthy detail in **V** are the steric effects introduced into this partial structure by the alternating bonds in biliverdin. In the crystal, the distinction between single and double bonds decreases when going from the "outer" methine bridges (C₅ and C₁₅), to the inner one (C₁₀) [1]. Although this x-ray result is partly due to a disorder effect [2], the difference between rings B and C is still enough that rotation around C₉, C₁₀ gives results different from the rotation around C₁₀, C₁₁. Thus, the *syn*, *E* form is sterically more hindered than the *anti*-*Z* form, its formal mirror image (Fig. 3). The latter is free of steric hindrance for all rotations, while no coplanar conformations are possible for the former.

If the atoms of the two pyrrole rings of **V** would have identical coordinates in Table I, both the *anti*, *Z* and the *syn*, *E* forms could be made identical by a rotation of 180° in the plane of the paper. It can, however, be taken from Table I, that a difference of 0.27 Å exists between the coordinates of C₈1 and C₁₂1. A further difference is between the angles C₁₀ C₉ N₂₂ (124.7°) and C₁₀ C₁₁ N₂₃ (122.3°). These differences cause different distances of C₈1...N₂₃ (2.20 Å) and C₁₂1...N₂₂ (2.64 Å) and, therefore, different energy contents of the planar conformations of the *syn*, *E* and *anti*, *Z* forms, respectively.

* See note added in proof.

The bond lengths C_9-C_{10} (1.37 Å) and $C_{10}-C_{11}$ (1.39 Å) are nearly identical in biliverdin dimethyl-ester, whereas $C_{15}-C_{16}$ (1.36 Å) has more double bond character than $C_{14}-C_{15}$ (1.48 Å). Provided a similar geometry at the C_{15} methine bridge of dihydrobilindiones, this increased asymmetry would destabilize the *E*-forms more strongly. The *anti*, *E* form proposed recently for the $\Delta 4$ -*E* isomers of bilindiones [6] indicates, however, that even this most hindered form is still accessible in a highly twisted conformation.

Steric interactions may play important roles during the $P_r \rightleftharpoons P_{fr}$ interconversions of phytochrome via intermediates [24] and for the conformational changes of chromophores associated with the denaturation and naturation of biliproteins [9, 25].

The chromophores of denatured (**I**) and probably as well of other biliproteins are predominantly in the cyclic-helical all-*syn*, *Z* form, while they have an extended configuration in the native state [19]. The driving forces for this conformational change are non-covalent interactions between the chromophores and the protein. The results presented allow an estimate of the energetics for rotations around the different methine bridges. Changes at the central methine bridge require only little energy. The steric interactions of the *Z*, as compared to the *E*-forms are small, but distinct, because the latter require a pronounced twist of the methine bridge (Fig. 3). Only the $N_{22} \cdots H \cdots N_{23}$ hydrogen bond is broken when going from the *syn*, *Z* to any other form. At the C_5 methine bridge, steric interactions impose restrictions on all forms, but only the *E* form is hindered at the C_{15} methine bridge. The energy difference between the *Z* and *E* isomers is, therefore, higher in the latter case, and the $\Delta G^\circ \approx 5$ kcal/mol determined recently [26] for the *Z*, *E*-isomerization of bilindione can then be taken as an upper limit for transformations at *any* methine bridge. This energy would have to be provided by the protein, which may be a reason for the comparably low folding energy of phycocyanins ([27], for a discussion, see [25]).

With regard to the phytochrome interconversion, two transformations are currently known for bile pigments which qualify for model reactions. One is the photochemical attack of nucleophiles at C_5 [28], the other is a *Z*, *E*-isomerization similar to the one observed by Falk *et al.* [5, 6] in bilindiones. For the latter reaction, the calculations presented here allow an estimate on which of the methine bridges is ex-

pected to be involved in the isomerization, as far as steric hindrance is concerned. No stable *Z*, *E* isomers are expected for the B, C methine bridge, due to the low degree of double bond character and the absence of steric barriers. The defined double bonds at the outer bridges ($\Delta 4,5$ and $\Delta 15,16$, respectively), make stable isomers possible [5, 6]. The considerable energy difference $\Delta G^\circ \approx 5$ kcal/mol [26] for $\Delta 15,16$ isomers is at least partly due to the pronounced twist imposed on the *E*-isomer by steric interactions. This energy difference is lowered at the A, B methine bridge, because the *Z*-forms are already strained in partial structure **IV**, which would at the same time decrease the activation barrier. This levelling effect may well be a reason for the well known increased reactivity of this position in 2,3-dihydrobilindiones (*cf.* [19]). The structural changes can further be restricted by the high rotational barriers between the three τ -minima. As only one τ -minimum is allowed for the *E*-configuration, this can be reached easily only from the corresponding *Z*-configuration. A cogwheel type rotation around C_3 , C_3I and C_4 , C_5 simultaneously, cannot decrease the barrier between the three τ -minima considerably, because the latter arise from interactions between C_5 or C_2I with the C_3 substituent. The strong twist expected for *E*-isomers would agree, too, with the short-wavelength shift of the P_{fr} chromophore in the denatured state [29].

In first order, the blue-shift of the long-wavelength band can be taken as a measure for the decrease in conjugation between *Z* and *E* isomers. For a fully unsaturated bilindione, $\Delta \bar{\nu} = 1000$ cm^{-1} has been reported [5, 6]. Compared to the shift of 1580 cm^{-1} for denatured P_r vs. denatured P_{fr} [29], this would indicate a rather strong distortion if the latter reaction were to correspond to a *Z*, *E* isomerization. Such a strong distortion for P_{fr} has also been concluded in a recent MO study [13].

The results are difficult to compare, however, because the data for phytochrome have been derived for the cationic forms, the ones for the *Z*, *E* isomers for the free bases. The chromophore of denatured P_{fr} is stable only as a cation, but reverts to the P_r chromophore above pH 5.25, the pK for the protonation of denatured P_r [29]. Unfortunately, data for the cations of *E*-isomers of bilindiones have not been published as yet, but they would be desirable for direct spectroscopic comparison between denatured P_{fr} and the *E*-isomer of bilindiones.

Acknowledgements

This work was supported by the Deutsche Forschungsgemeinschaft, Bonn-Bad Godesberg.

Note added in proof:

In biliverdin, a positive longwavelength Cotton effect has been calculated for the M-helical cyclic con-

formation [11]. This is in agreement with the CD-spectrum of denatured **pc** ($\theta = +133\,000/\text{chromophore at } 600\text{ nm}$, H. Scheer and P. Bartholmes, unpublished).

- [1] W. S. Sheldrick, *J. Chem. Soc. Perkin Trans. II* **1976**, p. 1457.
- [2] H. Lehner, S. E. Braslavsky, and K. Schaffner, *Angew. Chem.* **90**, 1012 (1978).
- [3] H. Lehner, S. E. Braslavsky, and K. Schaffner, *Liebigs Ann. Chem.* **1978**, 1990.
- [4] H. Falk, K. Grubmayr, and K. Thirring, *Z. Naturforsch.* **33 b**, 924 (1978).
- [5] H. Falk and K. Grubmayr, *Angew. Chem.* **89**, 487 (1977).
- [6] H. Falk, K. Grubmayr, E. Haslinger, T. Schleder, and K. Thirring, *Mh. Chem.* **109**, 1451 (1978).
- [7] H. Falk and G. Höllbacher, *Mh. Chem.* **109**, 1423 (1978).
- [8] M. J. Burke, D. C. Pratt, and A. Moscovitz, *Biochemistry* **11**, 4025 (1972).
- [9] H. Scheer and W. Kufer, *Z. Naturforsch.* **32 c**, 513 (1977).
- [10] Qu. Chae and P. S. Song, *J. Amer. Chem. Soc.* **97**, 4176 (1975).
- [11] G. Wagnière and G. Blauer, *J. Amer. Chem. Soc.* **98**, 7806 (1976).
- [12] T. Sugimoto, K. Ishikawa, and H. Suzuki, *J. Phys. Soc. Japan* **40**, 258 (1976).
- [13] R. Pasternak and G. Wagnière, *J. Amer. Chem. Soc.* **101**, 1662 (1979).
- [14] G. Klein, S. Grombein, and W. Rüdiger, *Hoppe-Seyler's Z. Physiol. Chem.* **358**, 1077 (1977).
- [15] G. Klein and W. Rüdiger, *Liebigs Ann. Chem.* **1978**, p. 267.
- [16] H. Lotter, G. Klein, W. Rüdiger, and H. Scheer, *Tetrahedron Letters* **1977**, p. 2317.
- [17] A. J. Kitaigorodskii, *Tetrahedron* **14**, 230 (1961).
- [18] W. Rüdiger, *Proceedings of the European Meeting on Photomorphogenesis*, Aarhus, **1978**, p. 53.
- [19] H. Scheer, *ibid.* p. 25.
- [20] K. Torü and Y. Iitaka, *Acta Cryst.* **B 29**, 2799 (1973).
- [21] W. S. Sheldrick, A. Borkenstein, J. Engel, and G. Struckmeier, *J. Chem. Res.*, in press.
- [22] W. J. Cole, C. O'hEocha, A. Moscovitz, and W. R. Krueger, *Eur. J. Biochem.* **3**, 202 (1967).
- [23] A. Gossauer and J. P. Weller, *J. Amer. Chem. Soc.* **100**, 5928 (1978).
- [24] R. E. Kendrick and C. J. P. Spruit, *Photochem. Photobiol.* **26**, 201 (1977).
- [25] W. Kufer and H. Scheer, *Hoppe-Seyler's Z. Physiol. Chem.* **360**, 935 (1979).
- [26] H. Falk, K. Grubmayer, E. Haslinger, and T. Schleder, *Mh. Chem.* **110**, 1237 (1979).
- [27] C. Chen and D. S. Berns, *Biophys. Chem.* **8**, 203 (1978).
- [28] C. Krauss, C. Bubenzer, and H. Scheer, *Photochem. Photobiol.* **30**, 473 (1979).
- [29] S. Grombein, W. Rüdiger, and H. Zimmermann, *Hoppe-Seyler's Z. Physiol. Chem.* **356**, 1709 (1975).