

Trace Element Metabolism in Man and Animals - 3

Proceedings of the 3rd
International Symposium
Freising, Fed. Rep. of Germany
July 77

General Editor
M. Kirchgessner

Institut für Ernährungsphysiologie
Technische Universität München
Freising - Weihenstephan

Contents

Introductory Lecture

Trace Element Research - An Expanding Field of Efforts in Human and Animal Nutrition

M. KIRCHGESSNER 1

Biochemical Functions of Trace Elements

Modes of Metal Metabolism in Mammals

E. FRIEDEN 8

Physiologically Active Amounts of Trace Elements

A.I. VENCHIKOV 15

Action of Some Trace Elements on Pepsin Activity

M. KIRCHGESSNER, H. STEINHART and M.G. BEYER 18

Regulatory Aspects of Copper in Metabolism

E.D. HARRIS and J.K. RAYTON 19

A Role for Copper in Microsomal Mixed Function Oxidases

N.T. DAVIES and K.W.J. WAHLE 23

Microbial and Hepatic Copper-Sulphur Proteins

H.J. HARTMANN, G.J. STROBEL and U. WESER 28

Ceruloplasmin, a Multifunctional Metalloprotein

E. FRIEDEN 36

Assignment of the Correct Oxidation State of Biochemically Active Copper

U. WESER and H. RUPP 40

Renal Accumulation of (Copper, Zinc)-Thioneins in Physiological and Pathological States

I. BREMNER, W.G. HOEKSTRA, N.T. DAVIES and R.B. WILLIAMS 44

Effect of Zinc Status of Rats on the Synthesis and Degradation of Copper-induced Thioneins

W.G. HOEKSTRA, I. BREMNER and N.T. DAVIES 52

Synthesis and Degradation of Hepatic Zinc-Thionein and Its Role in Zinc Metabolism

R.J. COUSINS 57

Effect of Age and Diet on Delta-Aminolevulinic Acid Dehydratase - A Zinc Dependent Enzyme

M. ABDULLA, S. SVENSSON, A. MATHUR and K. WALLENIS 64

Zinc and Copper Metabolism in Rats Administered Alpha-Mercapto-beta-arylacrylic Acids

E. GIROUX, N.J. PRAKASH, P.J. SCHECHTER and J. WAGNER 68

Structural Studies on the Selenoenzyme Glutathione Peroxidase

R. LADENSTEIN, O. EPP, Almuth RÖMISCH and A. WENDEL 72

The Labile Nature of Selenium in Oxidized Glutathione Peroxidase

H.E. GANTHER, J.R. PROHASKA, S.-H. OH and W.G. HOEKSTRA 77

Distribution of Selenium and Glutathione Peroxidases in Ovine Tissue Cytosols

P.D. WHANGER, M.J. TRIPP, R.S. BLACK and P.H. WESWIG 85

The Influence of Dietary Vitamin E and Selenium on the Metabolism of Selenium by Rat Liver

O.E. COKER and A.T. DIPLOCK 89

Effects of Fluoride on Cultured Cell Metabolism	
J. W. SUTTIE and M. G. REPASKE	93
<u>Absorption and Excretion of Trace Elements</u>	
Copper- and Zinc-Binding Ligands in the Intestinal Mucosa	
G. W. EVANS and P. E. JOHNSON	98
Homeostatic Adaptation of Zn Absorption and Endogenous Zn Excretion over a Wide Range of Dietary Zn Supply	
E. WEIGAND and M. KIRCHGESSNER	106
Studies on the Regulation of the Intestinal Absorption of Zinc	
F. J. SCHWARZ and M. KIRCHGESSNER	110
Homeostasis of Zn Metabolism in Experimentally Induced Zn Deficiency of Dairy Cows	
M. KIRCHGESSNER, W. A. SCHWARZ and H. -P. ROTH	116
The Effect of Injected Zinc on the Paneth Cell Population of the Rat Small Intestine	
Margaret E. ELMES	122
Effects of Protein, Amino Acids, Phytate and Cadmium on Zinc Absorption in Rats	
J. HATHCOCK and C. ABRAHAM	126
Zinc Absorption from Bread Meals	
Brittmarie SANDSTRÖM, B. ARVIDSSON, E. BJÖRN-RASMUSSEN and Å. CEDERBLAD	129
Age and Sex Effects on Trace Element Absorption from the Alimentary Tract	
W. H. STRAIN, W. J. PORIES, E. MICHAEL, R. M. PEER and S. A. ZARESKY	132
Endogenous Copper Loss in Cows: Its Origin Mainly in the Stomach System	
W. T. BINNERTS	136
Role of Bile and Diet on ⁵⁴Mn Metabolism in Animals	
J. W. LASSITER, E. ABRAMS, W. J. MILLER, M. W. NEATHERY and R. P. GENTRY	140
Intestinal Absorption of ⁷⁵Se from Sodium Selenite and L-Selenomethionine in Growing Poultry	
H. STANCHEV	144
Cobalt Excretion Test of Iron Bioavailability in Man and Mouse	
P. SALTMAN, J. HEGENAUER, L. RIPLEY and J. MORRISON	145
Cadmium and Zinc Bioavailability to Rats from Lettuce Leaves and Sulfate Salts	
R. M. WELCH and W. A. HOUSE	148
<u>Distribution, Storage and Interactions of Trace Elements</u>	
Mechanisms of the Molybdenum/Sulphur Antagonism of Copper Utilisation by Ruminants	
C. F. MILLS, I. BREMNER, T. T. EL-GALLAD, A. C. DALGARNO and B. W. YOUNG	150
A Study of the Effects of Dietary Sulphate on Molybdenum Metabolism in Sheep Using ⁹⁹Mo	
N. D. GRACE and N. F. SUTTLE	159
Effects of Low and High Copper Intake on Copper Metabolism in Pigs	
Monika SKALICKY, A. KMENT, I. HAIDER and J. LEIBETSEDER	163

On the Basic Mechanisms of Bone Tissue Participation in the Regulation of Blood Trace Element Levels N. M. LJUBASHEVSKY	167
Mathematical Model of Zinc Metabolism in Rat. Imitation of Zinc Deficient and Zinc Excessive Diets B. V. POPOV and V. S. BESEL	168
Zinc Kinetics and Metabolism in Rats Fed Diets with or without Phytic Acid W. A. HOUSE, R. M. WELCH and D. R. Van CAMPEN	171
Zinc Metabolism in Calves, Cows, Rats and Chicks Fed High Dietary Zinc W. J. MILLER, R. L. KINCAID, M. W. NEATHERY, R. P. GENTRY, M. S. ANSARI and J. W. LASSITER	175
Evaluation of Therapeutical Chelating Agents Using Computer Simulation P. M. MAY and D. R. WILLIAMS	179
Autoradiographic ⁶⁵ Zn Localization in Laboratory Animals C. GARCÍA-AMO, M. PEÑAS-AMO, S. JUNQUERA and A. SANTOS-RUIZ .	182
Adverse Effects of Copper, and to a Lesser Extent Iron, when Administered to Selenium-deficient Rats K. O. GODWIN, E. J. PARTICK and C. N. FUSS	185
Trace Element Concentrations in Eight Organs of Five Inbred Strains of Mice M. P. SIEGERS, K. KASPEREK, H. J. HEINIGER, G. V. IYENGAR and L. E. FEINENDEGEN	188
<u>Trace Element Deficiency and Physiological Consequences</u>	
Zinc Dependent Control of Food Intake, Taste and Smell Function R. I. HENKIN	190
The Combined Effects of Two Kinds of Metals Administered to Mice upon their Bitter Tasting and their Spontaneous Activity K. HOSHISHIMA, H. TSUJII and S. AOTA	199
Zinc: Brain and Behavioral Development H. SANDSTEAD, G. FOSMIRE, E. HALAS, D. STROBEL and J. DUERRE .	203
Effect of Magnesium Depletion and Repletion on the Behavior of Growing Rats D. OBERLEAS, D. F. CALDWELL, M. K. FROST, C. HOFER and J. J. CLANCY	207
Erythrocyte ⁶⁵ Zn Uptake In Vitro as an Aid to Diagnosing Zinc Deficiency J. K. CHESTERS and Marie WILL	211
Aspects of the Histology of Zinc Deficiency in Domestic Birds P. A. L. WIGHT and W. A. DEWAR	215
Effect of Zinc Deficiency on Digestibility and Utilization of Nutrients J. PALLAUF	218
Zinc - An Essential Element for Hair Growth J. M. HSU and W. L. ANTHONY	222
Accelerated Hepatic Heme Synthesis and Degradation in Selenium Deficiency R. F. BURK and Maria A. CORREIA	226
Molybdenum Deficiency in Ruminants M. ANKE, M. GRÜN, M. PARTSCHEFELD and B. GROPPPEL	230
<u>Progress in Research with Newer Trace Elements</u>	
Ni Deficiency and its Effects on Metabolism A. SCHNEGG and M. KIRCHGESSNER	236

Newer Trace Elements - Vanadium (V) and Arsenic (As) Deficiency Signs and Possible Metabolic Roles F.H. NIELSEN, D. R. MYRON and E.O. UTHUS	244
Essentiality and Function of Arsenic M. ANKE, M. GRÜN, M. PARTSCHEFELD, B. GROPPPEL and A. HENNIG	248
A Requirement for Silicon in Bone Formation Independent of Vitamin D Edith M. CARLISLE	253
Chromium in Autopsy Tissues of Diabetic and Non-diabetic American (Pima) Indians D.J. EATOUGH, L.O. HANSEN, S.E. STARR, M.S. ASTIN, S.B. LARSEN, R.M. IZATT and J.J. CHRISTENSEN	259
Effects of Chromium, Iron and Transferrin on Glucose Utilization in Protein Energy Malnutrition Günay SANER and C. T. GÜRSON	264
Urinary Chromium Excretion, Diurnal Changes and Relationship to Creatinine Excretion in Healthy Individuals of Different Ages C.T. GÜRSON and Günay SANER	267
Distribution Kinetics and Tissue Retention of Cr(III) in Rats C. ONKELINX, R. SRIVASTAVA and N. LEFEBVRE	268
The Peculiarities of Behaviour of Trivalent and Hexavalent Chromium in the Rats E.I. SUKHACHEVA, T. P. ARCHIPOVA and V.M. MASNA	268
Chemical and Biological Properties of Biologically Active Chromium R.A. ANDERSON, M. M. POLANSKY, J. H. BRANTNER and E. E. ROGINSKI	269
Progress of Chromium Nutrition Research W. MERTZ, R.A. ANDERSON, W. R. WOLF and E. E. ROGINSKI	272
<u>Nutritional Problems of Trace Elements in Man</u>	
Experimental Production of Zinc Deficiency in Man A. S. PRASAD, P. RABBANI, A. ABBASI, E. BOWERSOX and M. R. S. FOX	280
Discussion to "Experimental Production of Zinc Deficiency in Man" R. I. HENKIN	286
Hyperzincuria and Zinc Deficiency in Total Parenteral Nutrition A. M. van RIJ and Joan M. MCKENZIE	288
Zinc Balance Studies in Normal Infants E. E. ZIEGLER, B. B. EDWARDS, R. L. JENSEN, L. J. FILER, Jr. and S. J. FOMON	292
Zinc Supplementation of Low-Income Pre-School Children K. M. HAMBIDGE, M. N. CHAVEZ, R. M. BROWN and P. A. WALRAVENS ..	296
Zinc, Copper and Manganese Balance in Adolescent Girls Janet L. GREGER, O. A. BENNETT, S. BUCKLEY and P. BALIGAR	300
Copper Status of New Zealanders Barbara E. GUTHRIE, Joan M. MCKENZIE and Clare C. CASEY	304
Dietary Copper and the Copper Requirement of Man L. M. KLEVAY	307
Nutritional Adequacy of Current Levels of Ca, Cu, Fe, I, Mg, Mn, P, Se and Zn in the American Food Supply for Adults, Infants and Toddlers Barbara F. HARLAND, L. PROSKY and J. E. VANDERVEEN	311

The State and Supply of Selenium in Healthy Children and Dietetically Treated Patients with Inborn Errors of Metabolism Ingrid LOMBECK, K. KASPEREK, L.E. FEINENDEGEN and H.J. BREMER	312
Selenium in Human Nutrition in New Zealand Residents Marion F. ROBINSON, Christine D. THOMSON, R.D.H. STEWART, Heather M. REA and Robyn L. MCKENZIE	316
Selenium Concentrations in Human Urine and Drinking Water Theodora A. TSONGAS and S.W. FERGUSON	320
Selenium Content of Selected Foods S.N. GANAPATHY, B.T. JOYNER, D.R. SAWYER and K.M. HÄFNER	322
Effect of Sodium Fluoride on Skeletal Mass in Primary Osteoporosis I. ZANZI, J. ALOIA, K. ELLIS and S. COHN	323
Indices for Assessing Cadmium Bioavailability from Human Foods M.R. SPIVEY FOX, R.M. JACOBS, A.O. LEE JONES, B.E. FRY, Jr. and R.P. HAMILTON	327
The Absorption of Lead by Children D. BARLTROP and C.D. STREHLOW	332
<u>Medical Problems of Trace Elements Relating to Man</u>	
Use of Blood Trace Elements for Diagnosis of Heart and Liver Diseases Ludmilla R. NOZDRYUKHINA	336
Variation of Trace Element Concentrations in Normal and Inflamed Rat Tissue after Application of Chloro (Triethylphosphine) Gold K. KASPEREK and L.P. ANDA	340
Zinc Distribution in Human Serum, with Data on Alterations in Pregnancy and Hepatic Cirrhosis P.J. SCHECHTER, E. GIROUX and A. SJOERDSMA	343
Zinc Excretion and Plasma Zinc Level in Children with Nephrotic Syndrome E.W. REIMOLD	346
The Effect of Zinc Supply on Granulation Tissue in Young and Old Rats Ingrid TENGRUP, J. AHONEN, F. RANK and B. ZEDERFELDT	350
Zinc Requirement for Tumor Growth W.J. PORIES, W. De WYS, A. FLYNN, E.G. MANSOUR and W.H. STRAIN	354
Zinc Deficiency and Coeliac Disease A.H.G. LOVE, Margaret ELMES, M.K. GOLDEN and D. McMASTER	357
Role of Zinc and Copper in Experimental and Clinical Neoplasia A. MATHUR and K. WALLENIUS M. ABDULLA, I. IHSE, A. BRUN, A. RAUSING and S. SVENSSON	359
Trace Element Changes (Zinc and Copper) in Normal Nigerians, those with Sickle Cell Disease and Pulmonary Tuberculosis M.M. KAPU, A.F. FLEMING and G.M. EDINGTON	363
Zinc and Copper Investigations in Sickle Cell Anemia Lillian C. BUTLER, Martha L. TAYLOR, P.R. McCURDY and Louisa MAHMOOD	366
Effect of Copper Aspirinate on Regeneration of Gastric Mucosa Following Surgical Lesioning S.F. TOWNSEND and J.R.J. SORENSON	370
Does Copper Retention Play a Role in Liver Disease Other than Wilson's Disease D.M. DANKS and A.L. SMITH	373

Serum Copper and Ceruloplasmin Levels in Women Taking Oral Contraceptives J.G. SCHENKER	374
Manganese and Zinc in Experimental Diabetes of the Rat B. RIBAS, A. LOPEZ-CALDERON, J.M. CULEBRAS and M. DEAN	378
Levels of Iron, Copper and Zinc in Serum and Urine in the Diabetes Mellitus J.M. ^a CULEBRAS, M. ^a J. LUQUE, B. RIBAS, M. SANTIAGO and M. DEAN	381
The Effect on Experimental Mouse Typhoid of Chelated Iron Preparations in the Diet I.M. SMITH and R. HILL	383
Effects of Selenium, Arsenic and Zinc on the Genesis of Spontaneous Mammary Tumors in Inbred Female C₃H Mice G.N. SCHRAUZER, D.A. WHITE and C.J. SCHNEIDER	387
Antioxidants and Cancer VIII. Cadmium-Selenium Levels in Kidneys R.J. SHAMBERGER	391
<u>Genetic Disorders in Trace Element Metabolism</u>	
Results of a ⁶⁴Cu-Loading Test Applied to Patients with an Inherited Defect in their Cu Metabolism (Menkes' Disease) C.J.A. Van den HAMER and H.W. PRINS	394
Cu Content of the Liver of Young Mice in Relation to a Defect in the Cu Metabolism H.W. PRINS and C.J.A. Van den HAMER	397
The Cellular Defect in Menkes' Syndrome and in Mottled Mice D.M. DANKS, J. CAMAKARIS and B.J. STEVENS	401
Trichopoliodystrophy (TPD): New Aspects of Pathology and Treatment R.I. HENKIN and W.D. GROVER	405
The Urinary Excretion of Copper During D-Penicillamine Therapy P.J.M. W.L. BIRKER, H.C. FREEMAN and J.A.M. RAMSHAW	409
Zinc, Copper and Fatty Acids in Acrodermatitis Enteropathica K.M. HAMBIDGE, P.A. WALRAVENS, K.H. NELDNER and N.A. DAUGHERTY	413
Studies in Acrodermatitis Enteropathica P.J. AGGETT, D.J. ATHERTON, H.T. DELVES, J.M. THORN, A. BANGHAM, B.E. CLAYTON and J.T. HARRIES	418
The Influence of Oxychinolines on Intestinal Zinc Absorption and on Zinc Transport in Serum in Cattle T. FLAGSTAD	423
<u>Trace Elements in Gravidity and Lactation</u>	
Zinc Metabolism in Swine with Special Emphasis on Reproduction Inger WEGGER and Birthe PALLUDAN	428
Effect of Zinc Repletion for Limited Times on Parturition in Rats Jean APGAR	436
Studies on the Superretention of Trace Elements (Cu, Zn, Mn, Ni, Fe) during Gravidity M. KIRCHGESSNER, R. SPOERL and Ursula A. SCHNEIDER	440
⁷⁵Se-Selenite Tracer Study in Rats During Pregnancy and Lactation and a Comparison with Selenium Metabolism D. BEHNE, P. BRÄTTER, D. GAWLIK, U. RÖSICK and W. WOLTERS ...	444

The Effect of Milk Enriched with Zinc, Iron and Copper on 65-Zn Retention in Newborn Rats B. MOMČILOVIĆ	448
Zinc Binding Ligands in Milk and their Relationship to Neonatal Nutrition Lucille S. HURLEY, J. R. DUNCAN, C. D. ECKHERT and M. V. SLOAN ...	449
Relationship Between the Trace Mineral Content of Lactating Women's Milk, Serum and Dietary Intake L. A. VAUGHAN, C. W. WEBER and S. R. KEMBERLING	452
<u>Trace Elements in Animal Nutrition</u>	
A New Method for Estimation of Zn and Cu Status by Chelating Agents K. H. MENKE, H. -J. LANTZSCH and H. SCHENKEL	456
Zn Availability in Grains and Legumes H. -J. LANTZSCH, H. SCHENKEL and Ingrid NICKERL	460
Relationship between Different Criteria of Nutritional Quality and Availability of Trace Elements of Forages in Sheep M. LAMAND	464
The Trace Elements in Game as an Indicator for Some Disturbances and Diseases with Farm Animals in Bulgaria P. GABRASCHANSKY and L. NEDKOVA	468
Maternal and Lamb Breed Interactions in the Concentration of Copper in Tissues and Plasma of Sheep G. WIENER, I. WILMUT and A. C. FIELD	469
Determining the Copper Requirements of Cattle by Means of an Intravenous Repletion Technique N. F. SUTTLE	473
Comparisons of the Efficacy of Copper Injections of Different Compounds in Cattle with "Low Copper Status" J. J. KOOPMAN and A. WIJBENGA	480
The Effects of Cu-EDTA Injection on Weight Gain and Copper Status of Calves and Fattening Cattle P. A. M. ROGERS and D. B. R. POOLE	481
The Copper Status of Ruminant Animals in Northern Ireland in Relation to the Usage of Copper Compounds in Agriculture J. R. TODD	486
The Response of Young Growing Calves to Supplementation with Copper, Cobalt and Vitamin B₁₂ A. MacPHERSON, R. C. VOSS and J. DIXON	490
Effect of Soil Ingestion on Copper and Manganese Utilization by Swine J. K. MILLER, C. E. TYSINGER and S. L. HANSARD	494
Effect of Soil Ingestion on Cobalt Deficiency in Sheep A. MacPHERSON, R. C. VOSS and J. DIXON	497
Intake of Lead, Copper and Zinc by Cattle from Soil and Pasture I. THORNTON and D. G. KINNIBURGH	499
Some Factors Affecting the Incidence of Swayback in Lambs S. GHERGARIU	500
Studies on Iron, Manganese, Zinc, Copper and Selenium Retention and Interaction in Horses A. G. SPAIS, A. PAPASTERIADIS, N. ROUBIÈS, A. AGIANNIDIS, N. YANTZIS and S. ARGYROUDIS	501

Evaluation of Iron Proteinate for Indirect Prevention of Baby Pig Anemia E. R. MILLER, P. S. BRADY and P. K. KU	506
The Effect of Dietary Manganese on Egg Shell Quality and Manganese Concentrations in Some Tissues of Laying Hens B. PANIĆ, N. APOSTOLOV and Jovanka KNEŽEVIĆ	511
Molybdenum Responsive Syndromes of Poultry C. G. PAYNE	515
The Influence of Selenium and Vitamin E on the Erythrocyte Glutathione Peroxidase System of White-tailed Deer (<i>Odocoileus virginianus</i>) P. S. BRADY and D. E. ULLREY	519
The Effects of Selenium on the In Vitro Metabolism of Methionine by Rumen Microflora of Sheep M. HIDIROGLOU and C. G. ZARKADAS	523
The Effects of Varying Dietary Sulphate and Selenomethionine on Sulphur, Nitrogen and Selenium Metabolism in Sheep C. L. WHITE and the late M. SOMERS	526
Selenium Supplements in Salt for Sheep D. E. ULLREY, M. R. LIGHT, P. S. BRADY, P. A. WHETTER, J. E. TILTON, H. A. HENNEMAN and W. T. MAGEE	530
<u>Toxicity of Trace Elements</u>	
The Pathology of Chronic Copper Poisoning in Sheep J. McC. HOWELL	536
The Biochemical Role of Cadmium M. ANKE, A. HENNIG, B. GROPPPEL, M. PARTSCHEFELD and M. GRÜN	540
Effects of Low Level Prenatal Cadmium Exposure on Trace Metal Body Burden and Behavior in Sprague-Dawley Rats H. CHOUDHURY, L. HASTINGS, E. MENDEN, D. BROCKMAN, G. P. COOPER and H. G. PETERING	549
Interactions of Cadmium, Copper and Zinc in Animals Chronically Exposed to Low Levels of Dietary Cadmium J. K. CAMPBELL, N. T. DAVIES and C. F. MILLS	553
Sex Differences with Respect to the Accumulation of Oral Cadmium in Rats L. MURTHY, D. P. RICE and H. G. PETERING	557
Cadmium Induced Anaemia in a Work Force R. SCOTT, P. PATERSON, R. BURNS, K. BODDY, J. OTTOWAY, F. HUSAIN and G. S. FELL	561
The Effect of Ca and P on the Absorption of Cd L. B. SASSER, R. J. CHERTOK, M. F. CALLAHAM and G. E. JARBOE	562
Ultrastructural Changes in the Renal Cortex of Rats Exposed to Cadmium Elizabeth AUGHEY and R. SCOTT	566
Cadmium and Zinc in Horses C. -G. ELINDER and M. PISCATOR	569
Epidemiological Studies of Cadmium-induced Tubular Proteinuria Using Radio-Immuno Assay of Urinary β_2-Microglobulin for Diagnosis T. KJELLSTRÖM	573
Biochemical Changes in Workers Exposed to Molybdenum Dusts P. A. WALRAVENS, R. MOURE, C. C. SOLOMONS, W. R. CHAPPELL and G. BENTLEY	577

Zinc, Iron and Calcium Intakes of Lead Poisoned Children Who Practice Pica N. E. JOHNSON and K. TENUTA	582
Reduction in Tissue Storage of Lead in the Rat by Feeding Diets with Elevated Iron Concentration Kathryn R. MAHAFFEY, C. L. STONE, T. A. BANKS and G. REED	584
The Interaction of Iron and Lead J. QUARTERMAN and J. N. MORRISON	589
Lead, Protoporphyrin, and ALAD Levels in Human Fetal Erythrocytes P. M. KUHNERT, P. ERHARD and Betty R. KUHNERT	593
Physiological Responses of Week-old Ruminants to Lead Dosing G. P. LYNCH, D. F. SMITH, R. C. COPE and I. L. LINDAHL	597
Hematological Consequences of Lead Poisoning in Vitamin E-deficient Rats O. A. LEVANDER, V. C. MORRIS and R. J. FERRETTI	601
Effects of Dietary Selenium and Lead on Selected Tissues of Chicks M. C. BELL, J. A. BACON, G. R. BRATTON and J. E. WILKINSON	604
2, 3-Dimercaptosuccinic Acid as a Potentially Useful Therapeutic Agent for the Treatment of Heavy Metal Intoxication J. H. GRAZIANO	608
Studies on the Mechanism of Sex-linked Difference in the Toxicity and Reten- tion of Methylated Selenium Compounds Jana KALOUSKOVÁ, J. PAŘÍZEK, L. PAVLÍK and J. BENEŠ	611
Toxicity of Vanadium in Sheep C. B. AMMERMAN and S. L. HANSARD II	614
The Influence of Various Amounts of Tungsten on the Intensity of Oxygen Absorption in Guinea Pigs M. S. BALAEVA	617
<u>Future Aspects of Trace Elements</u>	
Future Aspects of Trace Element Analysis R. M. PARR	622
Some Contemporaneous Trends and Problems of Biogeochemistry V. V. KOVALSKY	627
The Biochemical Approach in Trace Element Metabolism U. WESER	631
Future Aspects of Trace Element Research in Physiology J. LEIBETSEDER	635
Future Aspects of Trace Element Research in Pharmacology W. FORTH	638
Future Aspects of Trace Element Research in Toxicology J. QUARTERMAN	642
Genetical Aspects of Trace Mineral Research F. PIRCHNER	646
The Future Role of Trace Metals in Medicine R. I. HENKIN	650
Future Aspects of Trace Element Research in Animal Production E. J. UNDERWOOD	654
List of Participants	659
Subject Index	668