The Transfer of Calcium and Strontium across Biological Membranes

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The Transfer of Calcium and Strontium Across Biological Membranes

Proceedings of a Conference held at Cornell University
Ithaca, New York, May 13–16, 1962

Edited by
R. H. WASSERMAN
Department of Physical Biology
New York State Veterinary College
Cornell University
Ithaca, New York

1963
ACADEMIC PRESS • New York and London

ACADEMIC PRESS INC.
111 Fifth Avenue, New York 3, N. Y.

United Kingdom Edition published by
ACADEMIC PRESS INC. (LONDON) LTD.
Berkeley Square House, London W.1

LIBRARY OF CONGRESS CATALOG CARD NUMBER: 63-21408

PRINTED IN THE UNITED STATES OF AMERICA

LIST OF PARTICIPANTS

ARMSTRONG, W. D., Department of Physiological Chemistry, University of Minnesota, Minneapolis, Minnesota

ASDELL, S. A., Department of Animal Husbandry, N. Y. S. College of Agriculture, Cornell University, Ithaca, New York

AVIOLI, L. V., Seton Hall College of Medicine and Dentistry, Medical Center, Jersey City, New Jersey

BARNES, R. H., Graduate School of Nutrition, Cornell University, Ithaca, New York

BERGER, E. Y., Research Service, Third N. Y. U. Medical Division, Goldwater Memorial Hospital, New York, New York

BERGMAN, E. N., Department of Physiology, N. Y. S. Veterinary College, Cornell University, Ithaca, New York

BERGSTROM, W. H., Pediatric Department, S. U. N. Y. Medical Center, Syracuse, New York

BERNSTEIN, D., Division of Medicine, Mount Sinai Hospital, Los Angeles, California

BORLE, A. B., Department of Radiation Biology, University of Rochester, Rochester, New York

BREEN, M., Northwestern University Medical School, Chicago, Illinois

BRONNER, F., Hospital for Special Surgery, Cornell University Medical Center, New York, New York

BUDY, A. M., Department of Physiology, University of Chicago, Chicago, Illinois

BREUER, L. H., Department of Animal Husbandry, Cornell University, Ithaca, New York

CHEN, P. S., Department of Radiation Biology, University of Rochester, Rochester, New York

CHOWDHURY, T. K., Department of Biophysics, University of Buffalo, Buffalo, New York

CLARK, I., Department of Orthopedic Surgery, Columbia University, College of Physicians and Surgeons, New York, New York

COMAR, C. L., Department of Physical Biology, N. Y. State Veterinary College, Cornell University, Ithaca, New York

CONNOR, T. B., Department of Medicine, University of Maryland School of Medicine, Baltimore, Maryland

COPP, D. H., Department of Physiology, University of British Columbia, Vancouver, B.C., Canada

COUSINS, B., Department of Radiation Biology, University of Rochester, Rochester, New York

CRAMER, C. F., Department of Physiology, University of British Columbia, Vancouver, B.C., Canada

CURRAN, P. F., Biophysical Laboratory, Harvard Medical School, Boston, Massachusetts

DANIEL, L. J., Department of Biochemistry, Cornell University, Ithaca, New York

DAVIS, A. K., Radiological Health Laboratory, Department of Health, Education, and Welfare, Public Health Service, Rockville, Maryland

DAVIS, G. K., Nuclear Sciences, Nutrition Laboratory, University of Florida, Gainesville, Florida

DELLA ROSA, R. J., School of Veterinary Medicine, University of California, Davis, California

DOBSON, A., Department of Physiology, N. Y. State Veterinary College, Cornell University, Ithaca, New York

DRAPER, H. H., Animal Sciences Laboratory, University of Illinois, Urbana, Illinois

DUPUIS, Y., Centre National Recherche Scientifique, Laboratoire du Physiolgie de la Nutrition, Paris, France

EGAWA, J., Department of Radiation Biol-

ogy, University of Rochester, Rochester, New York

FILONOWICH, L. K., Department of Physiological Chemistry, University of Minnesota, Minneapolis, Minnesota

FOWLER, E. B., University of California, Los Alamos, New Mexico

FRASER, D., The Research Institute, Hospital for Sick Children, Toronto, Ontario, Canada

FRIES, G. F., Department of Physical Biology, Cornell University, Ithaca, New York, and U. S. Department of Agriculture

FUERST, W. F., Department of Physiology, N. Y. State Veterinary College, Cornell University, Ithaca, New York

GARLICH, J. D., Poultry Department, Cornell University, Ithaca, New York

GASTEIGER, E. L., Department of Physical Biology, N. Y. S. Veterinary College, Cornell University, Ithaca, New York

GIESE, W., Department of Physical Biology, N. Y. S. Veterinary College, Cornell University; and Hannover, Germany

GRAY, L. F., U. S. Nutrition Laboratory, Cornell University, Ithaca, New York

GREENFIELD, L. J., Marine Laboratory, University of Miami, Florida

HACKLER, L. R., Department of Food Science, Cornell University, Geneva, New York

HANSEL, W., Department of Animal Husbandry, Cornell University, Ithaca, New York

HARDY, E., U. S. Atomic Energy Commission, Health and Safety Laboratory, New York, New York

HARKINS, R. W., Mead Johnson Research Center, Evansville, Indiana

HARRISON, G. E., Radiobiological Research Unit, Medical Research Council, Harwell, England

HARRISON, H. E., Pediatrics Department, Johns Hopkins University, Baltimore, Maryland

HAY, P., Strong Memorial Hospital, University of Rochester, Rochester, New York

HEANEY, R. P., School of Medicine, Creighton University, Omaha, Nebraska

HENDRIX, J. Z., Endocrinology Department, Rockefeller Institute, New York, New York

HENNEMAN, P. H., Seton Hall College of Medicine, Jersey City Medical Center, Jersey City, New Jersey

HOGBEN, C. A. M., Department of Physiology, State University of Iowa, Iowa City, Iowa

HOLLAND, R. F., Department of Dairy and Food Science, Cornell University, Ithaca, New York

HUBEL, K. A., 9001 Louis Avenue, Silver Spring, Maryland

HUNT, B. J., Department of Medicine, University of Toronto, Toronto, Ontario, Canada

ICHIKAWA, S., Department of Physical Biology, N. Y. S. Veterinary College, Cornell University, Ithaca, New York

JAINUDEEN, M. R., Department of Animal Husbandry, Cornell University, Ithaca, New York

JAYASINGHE, J. B., Ceylon

JOHNSON, R. F., Marine Laboratory, University of Miami, Florida

JOHNSTON, F. A., Department of Food and Nutrition, N. Y. S. College of Home Economics, Cornell University, Ithaca, New York

KIRSCHNER, L. B., Department of Zoology, Washington State University, Pullman, Washington

KODICEK, E., Dunn Nutritional Laboratory, University of Cambridge and Medical Research Council, Cambridge, England

KOPRIVA, P. C., State University of New York, New Paltz, New York

KOSIKOWSKI, F., Department of Dairy and Food Science, Cornell University, Ithaca, New York

LAGUE, JEAN-GUY, Faculty of Dentistry, University of Montreal, Montreal, Quebec, Canada

LAZOR, M. Z., National Cancer Institute,

National Institutes of Health, Bethesda, Maryland

LEDFORD, R. A., N. Y. State Department of Agriculture and Markets, Albany, New York

LENGEMANN, F. W., Department of Physical Biology, N. Y. S. Veterinary College, Cornell University, Ithaca, New York

LINDQUIST, B., University of Umea Medical School, Umea, Sweden

LOOSLI, J. K., Department of Animal Husbandry, Cornell University, Ithaca, New York

LUTWAK, L., Metabolic Diseases Branch, National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, Bethesda, Maryland

LYON, I., Department of Biochemistry, Chicago Medical School, Chicago, Illinois

MCFARLAND, W., Department of Zoology, Cornell University, Ithaca, New York

MCLEAN, F. C., Department of Physiology, University of Chicago, Chicago, Illinois

MALETSKOS, C. J., Physics Department, Massachusetts Institute of Technology, Cambridge, Massachusetts

MALM, O. J., Institute for Experimental Medical Research, Ullevaal Hospital, Oslo, Norway

MARCUS, C. S., Department of Physical Biology, N. Y. S. Veterinary College, Cornell University, Ithaca, New York

MASUHARA, T., Animal Research Institute, Canada Department of Agriculture, Ottawa, Ontario, Canada

MASUROVSKY, E. B., Department of Food Science and Technology, Nutrition, Massachusetts Institute of Technology, Cambridge, Massachusetts

MAURICE, P. F., Seton Hall College of Medicine, Jersey City Medical Center, Jersey City, New Jersey

MAYNARD, L. A., Department of Biochemistry and Nutrition, Cornell University, Ithaca, New York

MELLANDER, O., Göteborgs Universitet, Medicinsk – Kemiska Institutionen, Medicinaregaten 9, Göteborg, Sweden

MIGICOVSKY, B. B., Biochemical Research Branch, Canada Department of Agriculture, Ottawa, Ontario, Canada

MILLER, E. J., Radiation Biology Department of the School of Dentistry and Medicine, University of Rochester, Rochester, New York

MILLICAN, C., N. Y. State Department of Health, Rochester, New York

MONROE, R. A., Research and Development Division, National Dairy Products Corporation, Glenview, Illinois

MOORE, W., Southeastern Radiological Health Laboratory, Public Health Service, Montgomery, Alabama

MORI, K., Institut de Gerontologie, Hôpital Nôtre Dame de la Merci, Montreal, Quebec, Canada

MORRISON, M., Department of Food and Nutrition, Cornell University, Ithaca, New York

MULRYAN, B., University of Rochester Medical Center, Rochester, New York

NESHEIM, M. C., Poultry Department, Cornell University, Ithaca, New York

NEUMAN, W. F., Department of Radiation Biology, University of Rochester, Rochester, New York

NEWTON, C. F., Medical Department, University of Chicago, Chicago, Illinois

NICHOLS, B., Electrical Engineering, Cornell University, Ithaca, New York

NICHOLS, G., Harvard Medical School, Boston, Massachusetts

NICOLAYSEN, R., Institute for Nutrition Research, University of Oslo, Blindern, Norway

NORDIN, B. E. C., Medicine Department of Gardiner Institute, Western Infirmary, Glasgow, Scotland

OTERO, L. R., Department of Zoology, Columbia University, New York, New York

PACHA, F., Animal Research Institute, Research Branch, Central Experimental Farm, Canada Department of Agriculture, Ottawa, Ontario, Canada

PEACHEY, L. D., Department of Zoology, Columbia University, New York, New York

PEREZ, C. B., Department of Animal Husbandry, Cornell University, Ithaca, New York

PETERS, L. H., University of Oregon Dental School, Portland, Oregon

PRITHAM, G. H., Frear Laboratory, Department of Agriculture and Biochemistry, Penn State University, University Park, Pennsylvania

RAISZ, L. G., Department of Pharmacology, University of Rochester, Rochester, New York

RAY, R. D., Department of Orthopedic Surgery, University of Illinois College of Medicine, Chicago, Illinois

READ, M. S., National Dairy Council, Chicago, Illinois

REEVES, R. B., Department of Zoology, Cornell University, Ithaca, New York

RIVERA, J., U. S. Atomic Energy Commission, Health and Safety Laboratory, New York, New York

ROBINSON, B. H. B., Pharmacology and Experimental Therapeutics Department, Johns Hopkins University, Baltimore, Maryland

ROE, W. E., Department of Veterinary Physiology, N. Y. S. Veterinary College, Cornell University, Ithaca, New York

RUBIN, M., Chemo-Medical Research Institute, Graduate Chemistry Department, Georgetown University Medical School, Washington, D.C.

ROSENTHAL, H. L., Washington University, St. Louis, Missouri

SABETI RAHMATI, H., Department of Physical Biology, N. Y. S. Veterinary College, Cornell University, Ithaca, New York

SALTMAN, P., Department of Biochemistry and Nutrition, University of Southern California School of Medicine, Los Angeles, California

SAMACHSON, J., Veterans Administration Hospital, Hines, Illinois

SAVAGE, J. R. K., Department of Physical Biology, N. Y. S. Veterinary College, Cornell University, Ithaca, New York; and Harwell, England

SAX, N. I., Radiological Sciences Group, Division of Laboratories and Research, N. Y. State Department of Health, Albany, New York

SCHACHTER, D., Columbia University College of Physicans and Surgeons, Presbyterian Hospital, New York, New York

SCHRAER, H., Biophysics Laboratory, Physics Department, Penn State University, University Park, Pennsylvania

SCHWARTZ, R., Western Reserve University, Cleveland, Ohio

SHANES, A. M.,* Department of Pharmacology, Schools of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania

SINGER, L., Physiological Chemistry Department of the Medical School, University of Minnesota, Minneapolis, Minnesota

SNELL, F. M., Department of Biophysics, University of Buffalo, Buffalo, New York

SOLOMON, A. K., Biophysics Laboratory, Harvard Medical School, Boston Massachusetts

SPERELAKIS, N., Physiology Department, Western Reserve University, Cleveland, Ohio

STEIN, I., Orthopedic Department, Albert Einstein Medical Center, Philadelphia, Pennsylvania

STEVENS, C. E., Department of Veterinary Physiology, N. Y. S. Veterinary College, Cornell University, Ithaca, New York

TALMAGE, R. V., Biology Department, Rice University, Houston, Texas

TAVES, D., Department of Radiation Biology, University of Rochester, Rochester, New York

TELLES, N. C., New England Deaconess Hospital, Boston, Massachusetts

TEREE, T., University Hospitals, Cleveland, Ohio

THOMAS, W. C., Department of Medicine,

* Deceased

University of Florida College of Medicine, Gainesville, Florida

THOMPSON, R. C., General Electric Company, Hanford Atomic Products Operation, Richland, Washington

TIDBALL, C. S., Physiology Department, George Washington University, Washington, D.C.

TOVERUD, S. U., Institute for Nutrition Research, University of Oslo, Blindern, Norway

TWARDOCK, A. R., Department of Physical Biology, N. Y. S. Veterinary College, Cornell University, Ithaca, New York

URIST, M. R., Department of Surgery, University of California Medical Center, Los Angeles, California

VAUGHAN, O. W., Ross Laboratories, Columbus, Ohio

WALSER, M., Department of Pharmacology and Experimental Therapeutics, Johns Hopkins University, Baltimore, Maryland

WASSERMAN, R. H., Department of Physical Biology, N. Y. S. Veterinary College, Cornell University, Ithaca, New York

WAUGH, W. H., Department of Medicine, University of Kentucky College of Medicine, Lexington, Kentucky

WEIL, W. B., University Hospitals of Cleveland, Cleveland, Ohio

WELLMAN, H. N., Division of Radiological Health, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio

WHEDON, G. D., Metabolic Diseases Branch, National Institute of Arthritis, and Metabolic Diseases, National Institutes of Health, Bethesda, Maryland

WIDDOWSON, E. M., Department of Experimental Medicine, Medical Research Council, Cambridge, England

WILLIAMS, G. A., Radioisotope Service, Veterans Administration, Westside Hospital, Chicago, Illinois

WILSON, D. R., Department of Medicine, University of Toronto, Toronto, Ontario, Canada

WOODARD, H. Q., Sloan – Kettering Institute, New York, New York

WOOLLEY, D. W., Rockefeller Institute, New York, New York

WRIGHT, L. D., Graduate School of Nutrition, Cornell University, Ithaca, New York

YENDT, E. R., Department of Medicine, University of Toronto, Toronto, Ontario, Canada

YOUNG, C. M., Graduate School of Nutrition, Cornell University, Ithaca, New York

YOUNG, R. J., Poultry Department, Cornell University, Ithaca, New York

PREFACE

The present volume represents the proceedings of a Conference held at Cornell University, Ithaca, New York, May 13–16, 1962. The Conference, being of the same name as the title of this book, was organized upon the recommendation of a number of experts in the field. It was felt that there was enough new information and concepts becoming available to warrant a gathering of investigators for purposes of discussion and exchange of information. With the kind support of the U. S. Atomic Energy Commission, the National Institute of Dental Research, the National Science Foundation and Cornell University, such a meeting was made possible.

Calcium, of course, is an essential cation necessary for the functioning of several enzyme systems, for blood clotting, for normal nerve and muscle function, for bone formation and for maintaining the integrity of biological membranes. Its concentration in blood and other body fluids is closely controlled primarily by the action of the parathyroid glands. Strontium, not known to have any biological function, is of interest because of its presence in fissionable material and, for this volume, because of its similarity (chemical, physical and biological) to calcium. Considerable time and effort has (and is) being given to the problem of how calcium functions in these several systems. Perhaps related to this and of equal importance, is the question of how calcium moves across cells and cellular membranes. One may ask, for example, what types of transfer processes are involved and which predominates under normal physiological and nutritional situations? In reference to intestinal absorption, what mechanisms are available for altering the degree of calcium transfer in response to varying calcium intakes. How does vitamin D exert its effect? And what of the other factors, such as lactose, that also influence these processes? Is calcium reabsorbed from the kidney tubule by the same mechanism that operates in the intestine?

The problems concerning radiostrontium (Sr^{89} and Sr^{90}) are perhaps somewhat different but just as significant. After these radionuclides have been absorbed and deposited in bone, only a small amount can be removed except by exceedingly drastic measures. A more promising approach would be to prevent or depress their intestinal absorption as quickly and as efficiently as feasible. In order to attack this problem intelligently, one should know by what process or processes strontium is actually absorbed.

It was to such problems and questions as alluded to above that the theme of this volume (and the Conference) was addressed. Certainly, all of the answers are not yet available and many of the solutions are still many years away. It is hoped that this undertaking will serve to shorten, if only briefly, the lag time.

With gratitude, the fine cooperation of the program committee, consisting of Dr. R. H. Barnes (Cornell University), Dr. C. L. Comar (Cornell University), Dr. D. H. Copp (University of British Columbia), and Dr. H. E. Harrison (Johns Hopkins University) is acknowledged. Sincere appreciation is extended to the session chairmen who also served as sectional editors, these being: (I) Dr. A. K. Solomon and Dr. P. F. Curran (Harvard University), (II) Dr. B. B. Migicovsky (Canada Department of Agriculture, Ottawa), (III) Dr. R. Nicolaysen (University of Oslo, Norway), (IV) Dr. Bertil Lindquist (University of Umea, Sweden), (V) Dr. Felix Bronner (Hospital for Special Surgery, Cornell Medical Center), (VI) Dr. F. C. McLean (University of Chicago), (VII) Dr. D. H. Copp (University of British Columbia). Many others, particularly Howard Spicer, Jennifer Wheldon, Ruth Ditzell and Eleanor Rosica, were most helpful in the organization of the Conference and in the preparation of the discussion for the publisher. The suggestions and advice of Dr. C. L. Comar proved most valuable and his contributions are acknowledged with many thanks.

Ithaca, New York
October, 1963

R. H. WASSERMAN

INTRODUCTORY COMMENTS

Rapid progress in the gaining of fundamental knowledge is bound to result from a happy convergence of men with ideas and motivation, an opportunity for personal communication, a highly developed state of the art, and availability of material capabilities. The men with ideas are well represented here as contributors to this conference on calcium and strontium transport. The conference itself provides the market-place for ideas where sparks are expected from the clash of minds. Over the years there has been a sustained research interest in the nutritional and physiological aspects of calcium metabolism. Nevertheless, it is fair to state that the problems posed by the advent of atomic energy on a large scale provided considerable motivation and stimulation that led to intensification of studies of both calcium and strontium. Ironically, but perhaps with a measure of poetic justice, the same developments that brought the issue into being have also provided specific experimental tools and material capabilities that have furthered the solution of these problems as well as of many others.

Since the very early experiments, it has been generally accepted that calcium and strontium are interrelated in metabolic behavior. This means first of all that possible effects of radioactive strontium should be looked for in relation to those functions known to be dependent upon calcium:—skeletal processes, coagulation of blood, contractility of muscle, reactivity of the nervous system, and linkage in the nucleus of the cell. There is still a mild controversy about whether the behavior of adventitious radiostrontium in the mammalian organism is governed by the levels of stable strontium or by the homeostatic action of calcium plus strontium. Though many incline to the latter view, numerous observations yet remain to be explained. Hopefully, clarification will be provided by an understanding of the details of transport (e.g. competition, if any, for binding sites; carriers; energy sources). This conference, not entirely by chance, comes at a time when research in the broad area of mineral metabolism is about to take another tack. We know reasonably well what happens in the body under certain conditions to minerals such as calcium and strontium. Now we require to know why it happens and how we can change the pattern of events at will.

When the strontium problem first blossomed, it was optimistically thought that all the necessary information was existent in the voluminous literature on calcium:—ready for the taking. But the welter of conflicting views on even the most mundane aspects of calcium metabolism was disillusioning. It appeared that, if generalizations were to be possible, there must be much more basic information provided to shore-up the innumerable *ad hoc* findings.

It has been gratifying in a sense to see in recent years the interplay between practical needs and the fundamental approach. There has been general recognition and acceptance of the idea that feasible practical solutions will most likely be attained only if there is basic understanding of many aspects. The research that has been stimulated is no less fundamental or imaginative because of foreseeable relevance.

C. L. COMAR

The Transfer of Calcium and Strontium Across Biological Membranes

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