in a class period. The art of construction of such demonstrations is an extension of the automatic principles developed for manufacture and merchandizing.

The other desirable volume might be called "Showing off the Physical World." The demonstrations in this book should be designed for stage production for the fascination and education of the general public. In this connection one thinks of such performances as given by the Bell Telephone Laboratories, the General Electric Company, the Westinghouse Electric and Manufacturing Company and the General Motors Corporation.

F. C. BROWN

CHICAGO, ILLINOIS

# REPORTS

## GRANTS OF THE AMERICAN PHILOSOPHICAL SOCIETY

THE following grants in the natural and exact sciences were awarded by the committee on research of the American Philosophical Society in December, 1938, and in April, June and October, 1939. Grants in renewal of previous grants are not included, as these have already been published in SCIENCE.

Reginald D. Manwell, Syracuse University, for experimental animals in connection with the study of the exoerythrocyte cycle in avian malaria, and its relation to the development of immunity; the study to be centered about *Plasmodium circumflexum*. $300.

John Ernst Weaver, University of Nebraska, for technical assistance, travel in connection with studies on the damage done by drought, the adjustment of grassland to these injuries, and the method and rate by which prairie is being reestablished. $450.

University Museum, University of Pennsylvania, for excavations at Piedras Negras, Guatemala. $3,000.

Simon Freed, University of Chicago, for part payment of a research assistant in the study of the symmetries of the electrical fields about ions in solution and their relation to chemical thermodynamics. $750.

Francis Harper, John Bartram Association, for the preparation for publication, with annotations, of John Bartram's manuscript diary of his journey through the Carolinas, Georgia and Florida in 1765–66; of William Bartram's manuscript report to Dr. John Fothergill on his travels in the Carolinas, Georgia and Florida in 1773–74; and of a new edition of William Bartram's "Travels" (1791). $1,000.

H. H. Hess, Princeton University, and M. Ewing, Lehigh University, for traveling expenses in the continuation of a gravity survey of the Caribbean area and the correlation of the gravity field with the geologic structure. $1,000.

J. Percy Moore and Olin Nelsen, University of Pennsylvania, for the purchase of a micro-manipulator with a warm chamber to be used in connection with experimental studies on the free uterine eggs and blastocysts of the opossum to test the existence of embryonic organizers and the mutual interrelation of parts and related problems. $300.

Harvey Harlow Nininger, American Meteorite Laboratory, for field work in the search for and laboratory investigations of meteorites. $500.

Emil W. Haury, University of Arizona, for a part of the expenses of the excavation of a prehistoric village on Forestdale Creek, Fort Apache Indian Reservation, Arizona, occupying the area of direct contact between the Mogollon and Anasazi cultures. $500.

Research Council on Problems of Alcohol, for technical assistance, chemicals, animals and apparatus, to be used in connection with the study of the toxic factors in alcoholism. $1,500.

L. S. Cressman, University of Oregon, for field work in connection with the archeological exploration and excavation in southeastern Oregon. $600.

Samuel King Allison, University of Chicago, for part payment of a research assistant in making a precise measurement of the energies of short-range particles produced in nuclear disintegrations. $500.

James A. Shannon, New York University, for part payment for technical assistance in the study of the relationship between the renal tubular reabsorption of water and the role of the antidiuretic principle of the posterior pituitary; the effect of the composition of the body fluids upon the latter variable. $600.

Francis Owen Rice, Catholic University of America, for technical assistants in connection with his studies on the synthesis of polynuclear ring systems by a method of thermal polymerization. $1,000.

Merritt L. Fernald, Harvard University, for traveling expenses for himself and two assistants, equipment, etc., in connection with the collection of plants in eastern Virginia and the Carolinas. $1,500.

Carl C. Speidel, University of Virginia, for photographic equipment to be used in investigations of the histological changes exhibited by cells and tissues as these are subjected to various experimental procedures, and to record the changes by cinephotomicrography. $400.

Margaret Lantis, University of California, for travel and other expenses in Alaska involved in making an ethnographic study, through the complete seasonal round of the year, of the Eskimos of Nunivak Island, Alaska, as the culturally best preserved group of the important but little known Alaskan Eskimos south of Bering Strait. $950.

Robert W. Pennak, University of Colorado, for apparatus to be used in making a study of the comparative limnology of north central Colorado. $350.

Rodney H. True, University of Pennsylvania, for traveling expenses and assistance in making investigations of materials and personalities of significance alluded to in Thomas Jefferson's manuscript book on his garden operations at Shadwell and Monticello, Va. $750.

Louis W. Chappell, West Virginia University, for travel-

ing expenses and equipment for the collection and preservation of folklore in West Virginia; folk-songs, folk-tales, legends, riddles, proverbs, superstitions, animal and plant lore, etc. $500.

Karl Sax, Harvard University, for a technical assistant in studying the effect of radiation on chromosome structure. $600.

Arthur C. Cope, Bryn Mawr College, for a technical assistant in the study of three carbon tautomerism between 1-alkenyl and alkylidene malonic and cyanoacetic esters. $600.

Adam G. Böving, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, for traveling expenses in making an anatomical investigation of the taxonomically important structures of the larvae of the beetles of the genus *Phyllophaga*. $800.

Paul Weiss, University of Chicago, for apparatus, technical assistance, etc., in connection with his study of the "resonance" principle of neuromuscular coordination in mammals, studied by nerve crossing and muscle transplantation, using motion pictures and electrical action potentials as indicators. $350.

Charles B. Davenport, Department of Genetics, Carnegie Institution of Washington, for a statistical assistant in the study of postnatal development of the extremities in *Homo*. $500.

Richard H. Shryock, University of Pennsylvania, for traveling expenses in connection with the study of the modern history of irregular medical practice in Europe (medical sects, folk medicine and quackery) with particular reference to Great Britain, France and Germany and the influence exerted by developments therein upon the United States since the eighteenth cntury. $250.

B. Edwin Blaisdell, Massachusetts Institute of Technology, to hire a computer for the numerical integration of Laplace's differential equation for the equilibrium meridian of a fluid drop of axial symmetry. $250.

Herbert S. Harned and Gosta C. Akerlof, Yale University, for construction of apparatus for making vapor pressure measurements of high precision for solutions with one volatile component. $1,000.

Horace W. Babcock, Astrophysical Observatory, California Institute of Technology, for supplies, travel, etc., in connection with the systematic measurement of the spectrum of the night sky and of its integrated intensity, to discover the most favorable spectral region and the type of photographic emulsion to reduce the effect of this light to a minimum. $1,000.

Harry B. Friedgood, Harvard Medical School, for technical assistance, chemicals, etc., for the biochemical study of hirsutism and virilism in women. $500.

Roy Winfield Jones, Central State College, Oklahoma, for technical assistance, purchase of fish and equipment in determining the effect of growth-promoting substances, such as auxilin (indolebutyric acid), on the early differentiation of fish embryos, as expressed by the rates of cell division in such embryos. $275.

M. Bruce Fisher, R. I. State College, for equipment and machinist's labor in connection with the determination of the relation between the critical fusion frequency of flicker at the fovea of the human eye and the size, brightness and position of the surrounding field. $125.

Lloyd P. Smith, Cornell University, for a technical assistant and apparatus in connection with the electrical separation of the isotopes of calcium, phosphorus and boron in sufficient quantities for biological, medical and nuclear investigations, respectively. $1,500.

Dwight L. Hopkins, Mundelein College, for laboratory space, chemicals and supplies for further studies of the adaptation of amoebae to changing concentration and the regulation of the water content of the protoplasm. $250.

Frederick A. Saunders, Harvard University, to purchase a camera to be used in the investigation of the mechanical action of old and new violins. $500.

Benjamin R. Coonfield, Brooklyn College, for laboratory fees, supplies and traveling expenses in connection with an investigation on the problems of regeneration in the ctenophores and color change in embryo fishes. $300.

Paul R. Stewart and B. K. Stewart, Waynesburg College, for excavation, travel, slides, etc., in connection with a paleontological survey of the 1,100 ± ft. above the Monongahela formation in southwestern Pennsylvania. $500.

E. G. Anderson, California Institute of Technology, for a cytological technician to assist in the genetic and cytological analysis of the chromosomes of maize. $300.

Irvin M. Korr, New York University College of Medicine, for part payment of apparatus to be used in the study of the relation between cellular activity and cellular respiration in mammalian tissues, with particular attention to changes in rate, foodstuffs burned, and catalysts involved as the tissues are made to pass from the resting to the active state. $400.

Dorothy M. Spencer, University of Pennsylvania, for traveling expenses, equipment, informants, etc., in connection with an intensive study of one group among the Munda-speaking peoples of Central India. $1,500.

Richard C. de Bodo, New York University, for animals, chemicals, materials, etc., for the study of the cause and mechanism of the loss of hypersensitivity to insulin and the return of gluconeogenesis to a normal level. $850.

Leslie Lyle Campbell, Washington and Lee University, for apparatus, etc., for the continuation of investigations into the Hall and allied effects in metals. $350.

Morris H. Harnly and Ruth B. Howland, Washington Square College, New York University, for care of stocks, preparation of slides and technical assistance, in the analysis of the effect of the vestigial locus during the embryological and larval periods. $500.

Serge A. Korff, Bartol Research Foundation, to purchase a ten milligram radium-beryllium neutron source for the investigation of the disruption of the nuclei in the upper atmosphere by cosmic radiation. $325.

Isaac Starr, University of Pennsylvania Hospital, for an assistant in ascertaining and defining the clinical utility of the ballistocardiogram, an instrument which records the heart's recoil and the blood's impact in man. $480.

Eugene Pacsu, Princeton University, for technical assis-

tance, chemicals and apparatus for the physico-chemical investigation of polypeptides and proteins produced synthetically. $1,500.

Willis L. Tressler, University of Buffalo, for apparatus to be used in the limnological study of New York Lakes. $250.

Peter van de Kamp, Swarthmore College, for a technical assistant in making an accurate measurement of relative positions of close double star components by interferometer methods with special reference to close binaries with rapid orbital motion. $500.

Frances G. Wick, Vassar College, for a technical assistant, in making an investigation of the effect of neutrons as source of luminescence excitation and a study of the relation of luminescence to changes in physical state and changes in crystal structure. $500.

Carl A. Hoppert and Harrison R. Hunt, Michigan State College, for food for rats, laborer, etc., in connection with the determination whether there are inherited differences in rats with respect to susceptibility to dental caries, and if so to discover (if possible) the number of genes involved. $425.

Hudson Hoagland, Clark University, for an assistant in the investigation of the controlling chemical pacemakers (master reactions) involved in respiration of different brain centers. $600.

GRANTS AWARDED FROM THE ELDRIDGE REEVES JOHNSON FUND

*Academy of Natural Sciences of Philadelphia:*

James A. G. Rehn and John W. H. Rehn, for travel expenses in connection with field investigations of the *Orthoptera* of the Southern Alleghanies, Cumberland Plateau, Ozark and Ouachita Mountain Areas. $420.

# SPECIAL ARTICLES

## PHOTOSYNTHESIS WITH RADIO-CARBON

ANTICIPATING the appearance of a complete report now in preparation, we wish to summarize very briefly the results obtained in the past year using unicellular green algae (*Chlorella pyrenoidosa*)[1] and radioactive carbon dioxide ($\overset{*}{C}O_2$). In some respects the $\overset{*}{C}O_2$ reduction is similar to that found in barley and sunflower plants previously reported.[2]

The rate of photosynthesis was measured simultaneously by the Warburg manometer method and the radioactive technique. The two methods agreed within the experimental error. The $\overset{*}{C}O_2$ reduction was found to be markedly affected by such poisons as hydrogen cyanide and phenyl urethane. The light and dark reduction was enormously decreased by $10^{-2}$–$10^{-3}$ M. HCN. It was observed, manometrically,[3] that at these concentrations of HCN photosynthesis was strongly inhibited, whereas respiration remained unchanged. We feel certain, therefore, that the radioactive indicator method as applied to *Chlorella* is not complicated by possible reversible steps in the respiratory process.

As in the case of the higher plants,[4] *Chlorella* cells reduce $\overset{*}{C}O_2$ in the dark. We have found this to be a reversible reaction; 85 to 95 per cent. of the *dark* reduced radioactive carbon could be extracted by boiling approximately one minute with water; 70 to 80 per cent. of the C* in this extract was precipitated[5] by barium or lead ion in 80 per cent. ethanol. The barium precipitate from the *light* reduction extract contained a smaller fraction of the C*. Prolonged boiling with 1 N. HCl did not decrease the barium-insoluble radioactivity. These and other experiments indicate the presence of a carboxyl group in the radioactive molecule(s). Decarboxylation (dry distillation of barium salts) carried out on the dark water soluble material showed that most, if not all, of the labeled carbon was in the carboxyl group. To a far lesser extent this was also true of the light extract. A considerable number of naturally occurring carboxylic acids (*i.e.*, formic, acetic, propionic, oxalic, tartaric, malic, maleic, fumaric, citric, succinic, ascorbic) have been found inactive. Water-soluble proteins as well as a large number of molecules (aldehydes, ketones, ketoacids, carbohydrates, hydrolyzable polysaccharides) containing a free carbonyl group were also inactive. Benzoylation experiments indicated the presence of at least one alcoholic hydroxyl group in the radioactive molecule(s).

Preliminary experiments with glass diffusion discs (method of Northrop and Anson[6]) yield values for the diffusion coefficient of the radioactive substance in the water-soluble extract from *Chlorella* exposed to $\overset{*}{C}O_2$ for short times in light or dark which suggest the molecular weight to be large. A lower limit may be set at 200 although all indications are that the molecular weight is considerably greater.[7] Precautions were taken to ensure the diffusion measurements were made with a

[1] Sterile cultures were used. We are indebted to Dr. W. Arnold and Dr. H. A. Barker for much help and advice in this connection.

[2] S. Ruben, W. Z. Hassid, M. D. Kamen, *Jour. Am. Chem. Soc.*, 61: 661, 1939.

[3] O. Warburg, *Biochem. Zeits.*, 100: 230, 1919.

[4] E. D. McAlister, *Jour. Gen. Physiol.*, 22: 613, 1939, using a different method, has also found a dark uptake of $CO_2$ by wheat.

[5] A mixture of different carrier substances was added in all the chemical analyses.

[6] J. H. Northrop and M. L. Anson, *Jour. Gen. Physiol.*, 12: 543, 1929.

[7] Lack of information about the shape of the molecule(s) prevents a reliable estimation of the molecular weight. Experiments with Professor McBain using the ultracentrifuge are in progress and it is hoped these will make an accurate molecular weight evaluation possible.