

PRNC 70 PUERTO RICO NUCLEAR CENTER RESEARCH AND TRAINING OCTOBER 2, 1957
— DECEMBER 31, 1963 (OPERATED BY UNIVERSITY OF PUERTO RICO UNDER CONTRACT
NO. AT (40-1)-1833 FOR U.S. ATOMIC ENERGY COMMISSION ---Page Break--- 1 J TABLE OF
CONTENTS Background . Programs . Radioisotopes Applications Division . Clinical Applications
Division-2+2+seseeeee Radiotherapy & Cancer Division .. Medical Sciences & Radiobiology
Di Agricultural Bio-Sciences Division+---+++++++ Nuclear Science & Technology Division
.....+++++++ Health Physics Division ... Reactor Division Nuclear Engineering Di APPENDIX
Scientific Staff+-----seeeeeeeeeeeeeeeeeeeee Staff Publications .. Participation in Scientific
Meetings. Student Statistics Financial and Employment Data . 53 57 65 79 80 ---Page

Break--- PUERTO RICO NUCLEAR CENTER Following the rapid evolution of nuclear weapons, it
became possible to devote increasing resources to the non-military applications of atomic energy.
In 1953, President Dwight D. Eisenhower proposed to the United Nations General Assembly that
the nuclear powers should associate in this effort under the aegis of the United Nations. The United
States forthwith began a series of moves in compliance with the international commitment. Bilateral
agreements with over 30 nations were made to form the basis for effective international cooperation
in reactor development with special reference to nuclear power. The first Geneva Conference in
1955 involved the massive declassification of reactor technology and much fundamental
information concerning nuclear reactions and their physical constants. The value of international
cooperation being evident from this conference, the next step was the establishment of the
International Atomic Energy Agency as a special agency of the United Nations. Much of the early
program involved the European nations, Russia, United Kingdom, Canada, and the United States;
countries that had had a research and development interest in the field since the substantial resi

Beginning. Nuclear power development was pushed vigorously in the United Kingdom, while in
other countries the greater availability of fossil fuels permitted a broader exploration of reactor
concepts before the selection of the types most profitable to exploit. Although the prospective need
for nuclear power in Latin America seemed rather remote at the time, it was the general opinion
that the countries comprising Spanish and Portuguese speaking America would eventually find
themselves confronted with the necessity of moving to nuclear power. In the meantime, substantial
immediate advantages should accrue from a vigorous atomic energy program in general scientific
development, and especially in medicine and agriculture. At the 1956 Panama meeting of the
Organization of American States, President Eisenhower urged action by the Organization of
American States to hasten the beneficial uses of nuclear energy. As part of its effort to this end, a
study of the needs and potentials of Latin American countries was made by Admiral Paul Foster,
then Deputy General Manager of the United States Atomic Energy Commission. This indicated the
great need for technical training in a Latin American framework to make available the latest
knowledge and technology in the field. As a result of the study and his conferences with the officials
of the University of Puerto Rico, Admiral Foster recommended to the United States Atomic Energy
Commission the creation of a Nuclear Center in Puerto Rico to be managed by the University of
Puerto Rico. The recommendation was approved by the Commission and by the Department of
State. Joint planning studies were initiated by the University of Puerto Rico and the United States
Atomic Energy Commission (USAEC) for the proposed Nuclear Center. The responsibility for
implementing and administering the contract for the new Center was assigned to the Oak Ridge
Operations Office, whose Operations Manager, Mr. Sam Sapirie, negotiated with the University the
contract which gave substance.

and direction to the original concept. As part of the forward planning, the Tenth Oak Ridge Regional
Symposium was held at the University of Puerto Rico in Mayaguez, 1957. In an address to the

Symposium, Chairman Lewis L. Strauss of the Atomic Energy Commission said: "The broadened program will provide the University of Puerto Rico with unique training and research facilities. And because these facilities will be truly outstanding---the most up-to-date in concept and design---and because the instruction will be in Spanish, the University of Puerto Rico may well become a training center for many countries of the hemisphere. I can tell you that we will cooperate enthusiastically in the expansion." By January 23, 1957, Chancellor Jaime Benítez had appointed an Ad Hoc Committee of the University faculty to explore the development of graduate work in the natural sciences at the University of Puerto Rico, with particular reference to possible developments in the field of nuclear energy. Members of the Committee were: Dr. Marston Bates, Chairman, Director of Research; Dr. Conrado Asenjo, Department of Biochemistry, School of Medicine; Dr. Aníbal Cobas, Department of Physics, Río Piedras; Dr. Mariano García Rodríguez, Department of Mathematics, College of Agriculture and Mechanic Arts; Dr. Victor Rodríguez-Benítez, RUM Pilot Plant; Mrs. Marie Barton, Executive Secretary. The Ad Hoc Committee recommended to Chancellor Benítez the establishment of graduate studies and research at the University as a means of enhancing graduate studies and research. The Committee found that it further recommended that the proposed nuclear reactor be located in Mayagüez. Anticipating the forthcoming conclusion of a contract, the USABC awarded a grant of \$216,950 to the University of Puerto Rico to purchase equipment for the Radioisotope Techniques Training Center in Río Piedras to establish a program in Nuclear Science and Technology at Mayagüez.

Pronto eo rable et Ee, Roa Sie em re ieee ay ete fre Doge ge fe er aaa otce in hee,
Representatives of t ---Page Break--- feenntner to sou snrste ting vlog i he Cran 'The goal of the Puerto Rico Nuclear Center (PRNC) is to de oe vig Roe Rhus crt (5) it vee copes States Ptre re ee cis ma eet SERS LER Sota Stik hori riculture, industry. 'These programs employ the Spanish 'ane SASL PT eee 'he University of Puerto Rico is itself a charter member of the Union of latin fneflenn Universities and at the tine of te estabshish= font of the Buereo Rico Miclear Genter there were 313 staente from 19 herican Repuviice in ite stuant body. ihe total enrolinent of the University of Puerto Rico during the academic year 1956-57 we approxi- ately 16,000 with AML tine Faculty of 1,c8% Dr. Charles F. Bonilla, from Columbia University, agreed to serve ae Director of the Puerto Rico Nuclear Center for two years beginning October 16, 1957; Dr. José L. Garcfa de Qievedo was appointed Head of Research and Head of the Reactor Division; Dr. Anador Cobas was 94 pointed Head of the Radioisotopes Division; and Dr. Fred Soltero was named Head of the luclear Science and Technology Division. The first meeting of the complete PHIC staff vas held on Jamery 17, 1958, and an organization plan was discussed. Professor Warren Miller, Director of the Nuclear Technology Program at Pennsylvania State University, gave a seninar and acted es consultant to the staff. on July %, 1958, groundbreaking ceremonies for the Reactor Pail ing of PRNC were held in Mayaguez with Dr. Milton Bisenhower acting as official representative of the U.S. Government. 'An 8000 curie Cobalt-60 Therapy Unit was installed in April, 1959, at the Cancer Hospital where it remained until transfer to the Bio- Medical Building in early 1963. Dr. Charles Bonilla returned to Columbia University at the expira- tion of his leave of absence in September, 1959 and Dr. José L. Garcia de Quevedo served as Acting Director until July 1, 1960 when Dr. John Bugher is a member of the Rockefeller C.

Bugher was appointed Dr. Foundation and is on loan to PRNC at the request of Chancellor Benitez. Deputy Director Dr. Henry Gomberg joined the Nuclear Center in October 1965. On August 23, 1960, the PRNC Research Reactor was dedicated with Chancellor Jaine Benitez acting as Master of Ceremonies. Among the distinguished guests at the dedication were Senator Hickenlooper of the Joint Committee on Atomic Energy, Mr. Robert B. Wilson, Commissioner of the Atomic Energy

Commission, and Mr. Sol Luis Descartes, Vice-President of the Banco Crédito y Ahorro Ponceno. ---Page Break--- In Puerto Rico 1961, the hospital was the first section of the Bio-Medics branch of PRC to be established. The Medical Center at Río Piedras was occupied. In 1963, Dr. I. González Martínez's Oncologic Hospital was inaugurated and it became possible for the medical program to be more effectively consolidated with the Marine Biology and Oceanography Program, greatly benefited by the acquisition from the U.S. Army of a 200-ton diesel propelled vessel. It was renamed after the distinguished marine biologist, Bell Masayu, who died in Mexico in 1958. This vessel adapted to the requirements of the oceanographic ecological studies of the Luguillé, made possible by the U.S. Forestry Service request for the Terrestrial Ecology Program. The years covered by this condensed report were a continuation of facilities at several locations, recruitment and training of personnel, and the continual expansion of educational activities into states and disciplines to which nuclear reactions are relevant. As the year ended, PRNC was a vigorous and well-rounded institution, operating year-round across the three campuses of the University of Puerto Rico and active in all science departments of the University. From the small nucleus of personnel who had the courage to invite the new project, the staff had grown to a total of 226 persons by the end of 1963. The physical plant was completely operative, but the program had expanded so rapidly that the available space in laboratories had to

Much was contained in University buildings and temporary structures had to be erected to house the growing programs of the Puerto Rico Nuclear Center. In the first year of the operation of the center, it was necessary to conduct a considerable portion of the training program at the undergraduate level. With the growth of the graduate program, it was feasible to incorporate some of these entry courses in the regular undergraduate curriculum and to replace them with work at the graduate level in the Nuclear Center. Iki Shimada, who lost a position, has proved to be excellent in the operations of PRNC. The Experimental Forest provided an extensive area for construction. As a further expression of policy, it became generally accepted that the Puerto Rico Nuclear Center should function as an extension of various scientific departments having graduate programs so that graduate students would approach the Nuclear Center through the normal admission procedures of the University. Each graduate student consequently has his proper academic home under the general guidance of his department, with members of the Puerto Rico Nuclear Center staff participating on the appropriate committees.

The creation of the new Department of Nuclear Engineering in the College of Engineering completed a structure in which there is a separate unit corresponding to every phase of graduate education and training in the Nuclear Center. At the date of this report, the graduate programs are operating at the Master of Science level, although some of the departments will be prepared to operate at the doctorate level in the not too distant future. Since these are part of the requirements for a matter of degree, every graduate student taking work in the Nuclear Center is expected to complete a reasonable research problem as part of the required work. The problem is selected in consultation with the student and his advisor to address problems of yielding a reasonable solution in the time available.

Associated with the degree programs tends to be more restricted in scope and requires more immediate supervision than does that conducted at the post-doctoral and long-term project level. Thesis research, in accordance with the policy of considering graduate education as high-level training, a large part of the research capacity of the Puerto Rico Nuclear Center has been increasingly absorbed in thesis research conducted by candidates for M.S. degrees. Generally, the research problems selected are those of direct concern to the United States and especially to

Puerto Rico. The graduate student or visiting scientist who comes to the Puerto Rico Nuclear Center works on problems whose nature and dimensions he can study at first hand and where the results of his research may be put into perspective together with all of the other factors that compose the problem. Thus, for example, he learns about reactors, their design and operation, and the economic and engineering problems that must be solved if practical power production is to be achieved. He conducts his studies in an environment where he can observe a power system which, at a high level of efficiency, exploits hydroelectric, fossil fuel, and nuclear power plants, all subject to the same bases of economic analysis and all feeding into the same power grid. He can observe, if he wishes, the interrelations of rural electrification, small industries, and agriculture, all with unsolved problems and, in some instances, essentially with the same dilemmas that he finds in his own country. The Nuclear Center thus does not attempt to tell the student or visitor what the solutions to his country's development problems are; rather, he participates in a Puerto Rican effort to solve what are fundamentally U.S. problems. In special cases, and where the circumstances are favorable, the student may work on a primary scientific problem of importance to his own country, but this is the exception rather than the rule. The concept of "training" has been extended to a much higher level of

performance than is usually meant by the term. Graduate education and its associated research become in themselves training at a mature level. In the process, the student addresses professional problems and projects possible scientific output of his work. Some of this work may have an effect over time, for example, values obtained in studies of spoilage of tropical fruits or studies of retardation issues of radiation. The arrest of ripening can permit a marked reduction of losses compared to refrigeration. All of this work has been maintained and can continue for a considerable period in the future under the Education and Training Program. There is substantial ongoing research which is oriented to the needs of graduate students. The volume of many of the major problems of modern science are now well-defined projects which can be effectively adapted to subdivision into smaller projects. Inevitably, the Nuclear Center conducts research programs which are primarily directed to the acquisition of new knowledge and only secondarily useful to the program of graduate education. These research projects are supported by the appropriate divisions of the US-AEC. Here the objective of the research is appropriate rather than training; but these activities have had a profound effect on the vigor and content of the training programs. The economic impact in this way is through moderate means, etc. The requirement done by graduate students is slightly more than one half of the total program of the Nuclear Center is devoted to training and education, with the other portion being concerned with advanced research. All of the advanced portion is directed to matters of concern to the United States and to the immediate Caribbean region. Among these activities are those devoted to developing knowledge concerning the long-term effects of radiation and fission products on marine life and similar questions pertaining to the radioactive elements in tropical forests.

cycling of ra' Juestions which are intimately linked with the feasibility of constructing a new canal through Central America or the Isthmus of Panama using nuclear explosives for the earth removal. The scientific program has involved many sharp discussions at the Puerto Rico Nuclear Center, an institution of a multidisciplinary nature. The development decisions concerning the areas in which it should exert itself cannot expect to be effective in all scientific fields. A careful choice has been made, therefore, of those fields of endeavor wherein an institution on an island in the tropics can operate to advantage. ---Page Break--- RADIOISOTOPE APPLICATIONS DIVISION BASIC COURSE IN RADIOISOTOPE TECHNIQUES This course provides a thorough and intense introduction to the use of radioisotopes in scientific work. Topics discussed in lectures include a

review of the practices and principles of radiochemistry, biology, and health physics. Medical applications are also considered. Training in laboratory work is emphasized. **RADIOCHEMISTRY** Designed specifically for chemistry students, this one-semester course includes three hours of lecture and one laboratory period a week. The student is introduced to the fundamentals of radioisotope techniques in scientific research. The course covers the chemical aspects of nuclear processes and stresses the application of radioisotopes to chemical research. **NUCLEAR TECHNIQUES IN BIOLOGICAL RESEARCH** This is a one-semester course designed specifically for biology students, including three hours of lecture and one laboratory period a week. The course covers the fundamentals of radioisotope techniques in scientific research, the biological aspects of nuclear processes, and stresses the application of radioisotopes to biological research. **RADIOLOGICAL PHYSICS AND RADIOBIOLOGY** This is a month course given once a year, from August to September. Classes are given three times a week, plus one-hour laboratory twice a week. It is offered to Doctors in Medicine who are involved in Radiology.

in local hospitals. The course covers the fundamental concepts of radiological physics, the physics of diagnostic roentgenology, radiation measuring instruments, dosimetry, radiobiology, radiation protection, and the history of radiology. This is a three-hour lecture. **THESIS RESEARCH FOR M.S. DEGREE IN CHEMISTRY** may be done at the Puerto Rico Nuclear Center on a subject of mutual interest to the graduate student and his PRNC advisor. This division has active research programs in Organic Chemistry, Solution Chemistry, Photochemistry, Radiation Chemistry, and Physical Chemistry which provide excellent opportunities for graduate students. The research program in Chemistry is divided into three parts: Organic Chemistry, Radiation Chemistry, and Photochemistry. In addition, there is a new program in Solid State Physical Chemistry. The Organic Chemistry Program under the direction of Dr. H. H. Szmant includes the following projects: **NUCLEOPHILIC SUBSTITUTION REACTIONS OF IMIDATES** with E.P. Olavarria (supported by National Institute of Health grant). The purpose of the research is to develop a method of replacing an alcoholic hydroxyl group by a nucleophile via the imidate derived from the alcohol and a negatively substituted nitrile. In the first phase of this research, the mechanism of the base-catalyzed imidate formation is being investigated by kinetic means. Interesting and unexpected differences are being encountered in the reactivity of the isomeric cyanopyridines and different alcohols and glycols. **BETA-HYDROXY SULFOXIDES** with J. J. Rigau. As part of a program dealing with radiation protective agents, a series of beta-hydroxy sulfoxides has been synthesized by the oxidative addition of thiols to styrene and indene. The compound 2-(p-aminophenyl thionyl)-1-phenylethanol is now being tested at the Oak Ridge National Laboratories. Since the reaction produces four stereoisomers, these are being separated by

chromatographic means and it is hoped that infrared and nuclear magnetic resonance spectra will permit the assignment of the configurations to each isomer. Of special interest will be the relation between intramolecular hydrogen bond formation as a function of the substituents in the aryl sulfoxide portion of the molecule. **NUCLEOPHILIC SUBSTITUTION REACTIONS OF AROMATIC SYSTEMS** with A. Carrasquillo, Dept. of Chemistry, U-P-R. In connection with another problem, it is of interest to prepare perfluorobenzoic acid, p-iodobenzophenone and p,p'-diiodobenzophenone pertaining to radioactive iodine, and this is being attempted using nucleophilic substitution of iodine by iodide-131. The nucleophilic substitution reactions of aromatic systems in which the activating group is not a nitro substituent have been little investigated, and the kinetics of these reactions should be of fundamental interest. ---Page Break--- **NEW REACTIONS OF SULF " oxides:** 4th O. Cox, Depts of Chemistry, U-P-R. The exploration of reactions of sulfoxides in which the sulfur atom is transferred to either (a) another sulfoxide molecule, or (b) another compound, is being attempted.

The reactions of sulfoxides in this regard are expected to yield interesting new products. There are ongoing investigations to relate the structures of both compounds through the expected common product, namely the dichloroketene acetal derivative of deglucofuranose. ORGANIC DERIVATIVES OF DIBORON - with L.F. Pazos (supported by the Petroleum Research Fund, American Chemical Society). There have been prepared several members of a new class of derivatives of diboron and polyfunctional alcohols. The rates of formation of the new compounds, and the infrared spectra of the latter are also being studied.

Investigated in order to relate the position of the 3-0 bands with ring size and the nature of substituents. 'The Radiation Chemistry and Photochemistry Program under the supervision of Dr. Malcolm Daniels consists of the following projects: RADIATION CHEMISTRY AND PHOTOCHEMISTRY OF NUCLEIC ACIDS AND RELATED COMPOUNDS (supported by National Institute of Health grant). 'The work to date has been devoted to aspects of the photochemistry of thymine. Using radiation from low pressure Hg lamps and appropriate filters, it has been shown that thymine is rapidly photolyzed at 189 nm but not at 2537 nm. This rapid photolysis seems to be dependent on the presence of oxygen, and it has been found that a major product is a thymine hydroperoxide, together with hydrogen peroxide. Work in progress is devoted to identifying the other major products chromatographically and investigating in detail the kinetics of the reactions involved. ---Page Break--- 10 'This work promises to be of considerable importance if reactions of higher excited states are involved in radiation chemical processes, and should also clarify the mechanism of dimerization of thymine which seems to be of major importance in photobiology. Quite recently a rotating cylinder (Couette-type) viscometer has been acquired and work complementary to the above is being started on D.W.A. RADIATION CHEMISTRY AND PHOTOCHEMISTRY OF OXYANIONS (supported by USAEC Division of Biology and Medicine). Work started December, 1962. Spectral investigations preliminary to photolytic work have been carried out. In addition, studies on the photolysis of nitrate ion at 313 nm have been performed. Preliminary experiments indicated a strong and interesting pH dependence of nitrate formation in the alkaline region. There are three regions of obvious interest: (a) rate independent of pH from pH 2 - pH 6, (b) the small plateau centering on pH 10, (c) the strong increase from pH 11.5 to pH 14. 'The mechanism and kinetics of photolysis have been investigated for the first two of the above regions.

'The Physical Chemistry Research Program under the direction of Dr. Edwin Roig consists of the following projects: COMPLEXING OF THALLIUM (I) WITH AZIDE with R. Figueroa. Spectrophotometric evidence shows that thallium (III) complexes with azide. Data are not as yet conclusive but it seems the complexing is in a 1 to 1 molar ratio with a rather small association constant. Experiments are now being conducted to confirm results. DETERMINATION OF THE HYDROLYSIS CONSTANTS OF THE THALLIC SPECIES with J. Anziani. There is some doubt as to the hydrolysis constants found in the literature. The constants will be determined by potentiometric acid titrations of thallium (I)-thallium (III) solutions with constant ionic strength. After a long and tedious procedure of purifying reagents, all stock solutions required for the study have been prepared. At present the work is being delayed because of difficulties in eliminating leakage of very small currents through the mull detector in the potentiometer arrangement. ---Page Break--- RADIATION DAMAGE IN CRYSTALS USING AL CONDUCTIVITY. Infrared Spectrophotometer used in confirming molecular structures. ---Page Break--- Photoscanning equipment for tumor localization. ---Page Break--- CLINICAL APPLICATIONS DIVISION SHORT COURSE IN CLINICAL APPLICATIONS OF RADIOISOTOPES. Training is given over a two-month period in the clinical uses of radioisotopes in diagnosis and therapy. The course consists of formal lectures,

demonstrations, seminar roundtable discussions, review of literature, and laboratory work. Two techniques are introduced each week, preceded by an explanation of the theory and medical aspects of the tests. Participants perform approximately 60 tests during the six-week period. Procedures included are thyroid function studies, blood volume and cardiac flow, erythrocyte survival, location of cancerous metastases, gastrointestinal absorption, fetal and hepatic studies. COURSE IN CLINICAL APPLICATIONS OF RADIOISOTOPES. This is a six-month to one-year course which stresses the research.

aspects of radioisotopes in clinical medicine. The trainee concentrates on a special basic technique and pursues a research project within the scope of the Muclear Center's research program which is of particular interest to him. A preparatory period is allowed during which the trainee meets regularly with members of the staff to discuss problems related to such matters as experimental procedures, techniques, and biological supplies. ORIENTATION IN RADIOISOTOPE TECHNIQUES This is a one-semester course designed to orient the prospective physician to the uses and medical aspects of radioisotopes in clinical practice. Subject matter covers the general application of radioisotopes for diagnosis and treatment in medical practice. Under the direction of Dr. Sergio Irizarry, a varied program of medical research utilizing radioisotopes and biochemistry has been developed. A summary of the research project follows: THYROID PROJECT (in collaboration with Dr. Lillian Haddock, Head Endocrinology Section, University Hospital) 'A total of 310 cases from University Hospital records were abstracted to date. From these records we selected 11 hyperthyroid cases, 10 euthyroid cases, and 12 hyperthyroid cases that were typical of these functional conditions of the thyroid gland utilizing rigorous clinical laboratory criteria. From these patients the following data were retained: (a) hyperthyroid ranged from 61.1% to 97%. Average was 86.1%, standard deviation was 10.1%, Average minus three standard deviations was 7.27%. Total number of measurements taken from this (b) euthyroid ranged from 19.2% to 39%. Average was 22%, standard deviation was 5.66. Average minus three standard deviations was 3.36. Average plus three standard deviations was 42.63%. (c) Hypothyroid ranged from 1.1% to 12.1%. Average was 5.7%, standard deviation was 3.3%, and average plus three standard deviations was 16.64%. Our values have an overlapping between the hypothyroid and the euthyroid groups. This

overlapping is theoretically of the order of 13.2 on the basis of isotope studies alone in the group of hypothyroid and euthyroid patients having an uptake between 8% and 16-1/2%. We applied values between 16-1/26 and W7f for normal and from © to 8% for hypothyroid and on this basis the group found to be unclassified occurred in 17% of the measurements. Additional work will continue in defining the limits between hypothyroids and normals by collecting more cases. The differentiation between normals and hyperthyroids appears to be good. INTESTINAL FAT ABSORPTION PROJECT (in collaboration with Dr. A. A. Cintrén Rivera, Head, Clinical Research Laboratory, University Hospital) this is a study of intestinal absorption in patients undergoing radiotherapy. Seventeen patients have been examined to date and it was noted that a depression in oleic acid levels occurred in five of them while undergoing radiotherapy to the abdomen. TRIPLE ABSORPTION TESTS This study is designed to determine the feasibility of doing vitamin A, I-131 tagged oleic acid, and xylose determinations in the same patient simultaneously. Fifteen patients were examined to date and in 6 of them the three tests correlated well. Vitamin A and oleic acid correlated more closely than xylose in the group tested. Results were: 11 normal and 1 abnormal results with Vitamin A, 13 normal and 2 abnormal results with Radio-oleic acid, and 7 normal and 8 abnormal results with xylose. ---Page Break--- 6 SLOOD Levels of BLOOD LEVELS OF RADIO-OLEIC ACID IN HYPERTHYROID This project is designed to test the capacity of the

unmeasured and categorized to detect the total level and interests of the set and apparently the gastrointestinal tract. The unblocked thyroid gland supposedly will remove inorganic radioactivity. We have measured 10 hyperthyroid patients and have found the expected caveat hyperthyroid patients and have found the expected expression in the blood radioactivity level in all TUMOR LOCALIZATION The scanning equipment for tumor localization has

been moi sees henner loetctin thn att sere Dprtn arb oh Pw et a ek Sst iets rez fo ars eft 8 pling eee eines et cet eee eat a eaela ois ste an eects on, uel conning ee Senet Tages aon etaesmine eet eto eral tees ee eal eer oleae esol eee eae ae cele ae ee aera P eer ler nelle tee ee eet See era rae ee re ree ieee study other organs and tumors. **RENOGRAM STUDIES IN RABBITS**
RENOGRAPHIC CHANGES IN PARTIALLY RADIATED KIDNEYS IN RABBITS (in collaboration with Captain William L. Caldwell, Army Tropical Research Laboratory) Thirty-two rabbits were subjected to partial renal damage by radiation. Renal function is being followed up by sequential examinations employing the hippuric acid radioisotope renogram. **DETECTION OF EARLY RENAL DYSFUNCTION BY MEANS OF TUBULAR LOADING DURING RENOGRAMS** Dr. Marcelo Bertholds Nine patients in whom equal damage was suspected but not proved by routine laboratory methods were subjected to a double isotope study: (a) The standard renographic procedure. (b) Renography under the load of 8 grams of sodium-para-aminohippurate (P.A.H.) given by slow intravenous injection. In eight of the nine patients in whom a routine ---Page Break--- **6 Automated Biochemical Analysis ---Page Break---** **RADIOTHERAPY AND CANCER DIVISION**
RADIOTHERAPY RESIDENCY PROGRAM This is an approved program for radiotherapists that fulfills the requirements of the American Board of Radiology. Physicians with a year of internship or equivalent clinical experience are accepted. The training period lasts three years, but trainees are required to take an additional year of supervised practice (preceptorship) before admission to the specialty examinations. Trainees learn to diagnose cancer, to determine the extent and radiosensitivity of a tumor, to choose the appropriate treatment, and to plan and conduct radiological therapy. Background in clinical oncology is imparted to residents through work with new, follow-up, and hospitalized cancer patients. Radiation therapy experience is acquired by working with roentgen.

therapy machines of various voltages, cobalt teletherapy units, and the application of radioactive materials such as radium, strontium cobalt, and iridium. Trainees become familiar with cancer control activities in Puerto Rico which include a central cancer registry, tumor clinic work, cancer detection, and public and professional education in cancer. Regular teaching activities include: bi-weekly treatment planning conferences, weekly clinical cancer conferences, weekly Oncologic Hospital Tumor Board conferences, weekly University Hospital tumor conferences, weekly Nuclear Center seminars, weekly hospital grand rounds, bimonthly and monthly cancer seminars. The following special courses are included: Radiological Physics, Medical Statistics, Bio-Chemistry of Cancer, Radioisotope Techniques, Radiobiology, and Tumor and Tissue Culture. **SHORT TERM RADIOTHERAPY TRAINING PROGRAM** Special programs are prepared according to the needs of the applicant. Participants may engage in a research project and may participate in all teaching activities of the Radiotherapy and Cancer Division, but are not given patient responsibility. Under the direction of Dr. Victor A. Marcial, an active program of cancer research has been developed: **CARCINOMA OF THE PENIS** (in collaboration with Dr. J. Colén, Oncologic Hospital, and Drs. J. Figueroa Colén and Raúl A. Marcial Rojas, School of Medicine) Data obtained indicated that cancer of the penis is three times as frequent in Puerto Rico as in the continental United States. Regarding treatment, it was found that small lesions can be treated with radiation therapy sparing amputation of the organ with a satisfactory five-year survival (65%). The results were published in Radiology

August, 1962. ---Page Break--- CANCER OF THE ESOPHAGUS (in collaboration with Dr. Pablo S. Auxilio Mato Hospital, and Drs. Raúl A. Marcial Rojas, School of Medicine) The first phase of the project concerns epidemiological investigation of the probes of cancer of the esophagus in Puerto Rico. It has been found

that the mortality from cancer of the esophagus in Puerto Rico in both sexes is the highest in the world. The second phase of the project concerns investigation of the clinical features of 400 cases of cancer of the esophagus from the Dr. I. González Martínez. The task of abstracting information from the Oncologic Hospital patients' records, the preparation of coding sheets and perforation of IBM cards was completed. We are awaiting the radiodiagnostic and histopathological evaluation of the cases before proceeding with the final report. HODGKIN'S DISEASE (in collaboration with Dr. Eduardo de León, School of Medicine) In this project, 83 cases with Hodgkin's disease from the González Martínez Oncologic Hospital records were investigated. It was found that the highest survival was achieved in the last seven years when the modalities of treatment included radiation therapy for the involved areas and the adjoining potentially involved regions. The data on these cases will be placed on TM cards for final analysis and from Dr. I. González Martínez's publication. CARCINOMA OF THE ANTERIOR TWO THIRDS OF THE TONGUE (this is a clinical project by Dr. José M. Toné and Dr. Victor Marcial) An evaluation of the clinical aspects of 197 cases of cancer of the anterior two thirds of the tongue seen at the Dr. I. González Martínez Oncologic Hospital is in progress. Etiological factors and evolution of the disease are considered. An appraisal of the benefits of various treatment methods is also included. EVALUATION OF RADIATION RESPONSE IN CASES WITH CANCER OF THE CERVIX UTERI TREATED WITH RADIOTHERAPY BY MEANS OF EXFOLIATIVE CYTOLOGY (in collaboration with personnel of the Cytology Laboratory of the Puerto Rico Department of Health) The aim of the project is to determine the validity of exfoliative cytology as a prognostic tool in cases with cancer of the cervix uteri treated with radiation. So far, 356 cases have been studied. This is a long-term project that will require a minimum of two years. Only 152 cases qualify for the minimal two.

Observation in each case. Year follow-up. As an initial step in the analysis of the data collected, a study of the significance of persistent tumor cells in the vaginal smear at the end of external radiation therapy is being conducted. The purpose of this initial analysis is to determine if the presence or percentage of cells at the end of external radiation correlates with prognosis. Cases with at least two year follow-up will be used for this study.

Irradiation of the Kidney (in collaboration with Dr. Wilten Caldwell of the Rodríguez Army Hospital) The objective of the study is to devise treatment techniques for cancer in or around the kidney area that would prevent damage to this organ. One aspect of the study concerns investigation of shielding portions of the kidney during irradiation. For this, a group of 32 rabbits were divided at random into four groups of 8 animals each. The animals were given localizing excretory urograms and were subsequently radiated with 2000 rads in a single dose with cobalt 60. The following portals were used: Group I - The lower half of both kidneys was irradiated. Group II - The medial half of both kidneys was irradiated. Group III - Both kidneys were irradiated. Group IV - (control) - the left kidney was irradiated. At present, three months after irradiation, 19 rabbits are still alive; 6 in group I, 5 in group II, 2 in group III, and 6 in group IV. As expected, animals in group III did the poorest. Twenty-six weeks after the conclusion of renal irradiation, the animals remaining will be killed and necropsies with histologic examinations of the renal tissues will be done. Renograms using Hippuran I-131 before irradiation, 2-1/2 weeks, 4-1/2 weeks, and 8-1/2 weeks after irradiation have been informed. The data will be analyzed after the study is completed. A preliminary study

was performed in which young adult New Zealand rabbits had the left kidney irradiated with a dose of 3,900 rads in 3 weeks. One group received 25 mg. of Triiodothyronine daily.

and the Sther group was the control. Triiodothyronine did not protect the kidney against radiation, but made it worse. The average kidney weight in animals irradiated and receiving l-Triiodothyronine was 1.8 g, and the average kidney weight in animals of the control group was 3.1 g. The right kidney that was not irradiated had a similar weight in both groups, 11.7 and 11.9 g.

IRRADIATION OF THE EYE 'The objective is to develop treatment techniques for tumors in and around the eye with preservation of vision. The initial part of the project concerns the investigation of the role of oxygen in the radiosensitivity of the lens. ---Page Break--- The qualitative 8,000 Curie Cobalt-60 Teletherapy Unit being adjusted prior to irradiation ---Page Break---

a MEDICAL SCIENCES AND RADIOBIOLOGY DIVISION Training activities of the new division have been directed to improving the competence of PANG Eleaedictetiniclae fn'tiome. In 1963, it should be possible to accept a small master of state from other countries. OF students Under the direction of Dr. M. Paul Wetnbren, the following research activities have been initiated: * ae * STUDY OF CHROMOSOMES IN CULTURED HUMAN LEUCOCYTES (in collaboration with Col. M. Dacquisto, Director, U.S. Army Tropical Research Medical Laboratory) Specimens have been prepared from more than 100 persons with the majority taken from normal healthy individuals. The abnormalities currently under study are drawn from patients receiving radiation therapy for malignant disease and from those suffering from "sprue". OBSCURE ACUTE NEUROLOGICAL SYNDROMES IN CHILDREN (in collaboration with Dr. Dolores Méndez Cashion, Pediatrics Dept., University Hospital--support from National Institutes of Health) consists of a systematic search for the presence of enteroviruses in serial rectal swabs from the children part of this program. The tissue culture unit of this division undertook the screening of 100 pairs of swabs in August, 1963 and from 22 of the 200 acts.

of culture tubes inoculated we recovered agents which caused a cytopathogenic effect both in the primary tubes and on passage. Native, yeraenoGeon saved for transmission to NIH for final identification of these agents. In 6 cases "agents" came from paired swabs and in the remaining 10, only from one of the pair in spite of repeated isolation attempts from the "sterile partner".

RADIATION INDUCED VARIABILITY IN INDIGENOUS ARTHROPOD BORNE ANIMAL VIRUSES OF PUERTO RICO--TERRESTRIAL ECOLOGY PROGRAM, PART II (support from USAEC Division of Biology and Medicine) Support for this program was received in April, 1963, but the initial few months were spent in recruiting personnel and training them. Now we have established a mouse colony holding space and ---Page Break--- has been activated. It is anticipated that the permanent laboratory will be ready for occupation by the end of 1964, or at the latest, in the first quarter of 1965; experiments have been oriented towards mosquitoes and relevant studies which are marked and released. At and are set weekly to trap mosquitoes which are bled for antibody studies and also selected for virus isolation. Mosquitoes are caught in light traps for attempted virus inoculation on human bait. After identification, they are then stored in bovine serum albumin and the resulting mosquitoes are processed into a suspension to attempt virus isolation. To date, suspensions have been made from material collected at the El Verde Field Station. Laboratory quarters and the program anticipated that the permanent small animal: DENGUE VIRUS ISOLATION In August, 1963 a "Dengue-Like" illness occurred on an epidemic scale in the town of Manatí, Puerto Rico. Manatí is situated 3.5 miles inland at the midpoint of the northern coast 5 miles west of San Juan. It is probable that cases of the disease occurred elsewhere on the island before the epidemic at Manatí. Shortly after Manatí was declared an epidemic area, cases occurred in the San Juan area and notably in Bayamón. From

Here it "moved" to the eastern end of the island and then down the coast with what would appear to be the last cases in the neighborhood of Ponce, which is situated to the west of center on the southern coast. The Puerto Rico Nuclear Center became involved in the measures taken to study the disease when the Arbovirus unit of the Medical Sciences Division was invited to join Dr. Costa Mandry's team from the Department of Health and a team from the Communicable Disease Center, Atlanta, Georgia. (On August 23 it was arranged that specimens could be collected from acutely ill patients in Manatí and 2 patients were bled by the team of the Puerto Rico Nuclear Center to which Dr. Agustin Cajigas of the Department of Health had been assigned for duty during the investigation. On August 29, 1963, Dr. Telford Work, Chief, Virology Section at C.D.C., visited Manatí with Dr. Cajigas and they obtained specimens from 6 individuals previously bled and 5 who claimed to have been afflicted in the past 3-4 weeks. On receipt of these specimens, at about 9:00 P.M., they were immediately processed and set up in a hemagglutination-inhibition test against Dengue type I antigen provided by C.D.C., Atlanta. The erythrocytes were added to the test at 5:00 A.M. and the test read at 6:00 A.M. on August 30. The results are set out below; the results identified by letters pertain to the sera from the individuals with a "history" of disease. ---Page Break--- Acute convalescent specimen serum titer are #6 3:20 fe 120 is hizo a3 hizo he 1120 L:ç2h0 4 13640 3 > z From these results, it was clear that the disease was associated with an agent which is related to Dengue I type virus. (Until such time as an agent is adapted to regularly kill a laboratory animal, it is not possible to establish its exact identity). The agent which caused the illness in Puerto Rico was in all probability the same as that which caused the epidemic in Jamaica a few weeks earlier. It has proved unusually hard to adapt to either laboratory mice or tissue culture.

Several different groups have been working with it but none has had any success in fully adapting an agent from many samples of material. The contribution of the Puerto Rico Nuclear Center to the overall effort lay largely in the initial preparation and screening of specimens collected in the field. In all 1,237 human blood specimens were centrifuged, the serum separated and then pooled. One ml of each serum was prepared for testing by the haemagglutination inhibition test. Aliquots of all specimens were sent to C.D.C., Atlanta, both for attempted virus isolation and serological study. Of the 1,237 sera 88 were taken in the first 12 hours of illness and in the PRIC laboratory were inoculated into infant mice and tissue cultures to attempt virus isolation. Mosquitoes were processed in 208 pools. The distribution by species is shown below: *A. aegypti* 6,849 *C. quinquefasciatus* 10,983 *C. nigripalpus* % *Culex* species 85 Total — 17,943 From the acute blood specimens and from some pools of mosquitoes, agents have been obtained which cause transient illness in infant mice ---Page Break--- are also affect in African green monkey (*Cercopithecus aethiops*) kidney tissue cultures. The presence of virus may be in affected guassauiens using the fluorescent antibody technique. In the hopes of increasing their pathogenicity, two strains of virus are in continuous passage in Anta mice and two more are in serial passage in infant mice which have been irradiated with 250 rads of X Ray (from a 350 KVP machine) prior to inoculation in order to decrease their natural resistance to the agent. A haemagglutinin has been made from 2 strains of virus but its potency is so low that it is of little value for practical purposes. a SCHISTOSOMIASIS (supported by USAEC Division of Biology and Medicine) authorization for this program was received on December 3rd, 1963, and although at this time no results are available, the program is based upon work by Dr. John Villella and Dr. Henry J. Gonberg while at the University of Michigan, and on

basically similar information published by Sadun et al. Both these groups reported an acquired

resistance to challenge with virulent *Schistosoma mansoni* cercariae after infection by cercariae which had been damaged by exposure to gamma irradiation. The differences in the results of these groups appear to be related to the employment of different routes of infection; while Villetla uses intraperitoneal infection, Sadun et al. prefer the percutaneous route. It is the object of the present program to perfect more delicate means of assessing the degree of protection obtained and then to establish the conditions required to produce the greatest possible degree of protection. Experiments have also been designed to test the duration of the protection conferred and the stages at which various serological tests yield positive results. When the optimal experimental procedures have been established it is intended to make a detailed study of all detectable reactions which occur between the challenging parasite and the "immune" host. The problems attendant upon reasonably accurate quantitation of the "immune response" or degree of protection conferred upon a mouse which has been exposed to irradiated cercariae are virtually insuperable using techniques in current use by parasitologists. It is proposed to explore the possibility of defining an "infective dose" based on number of live cercariae. ---Page Break--- Mosquito identification ---Page Break--- Greenhouse Bias in AREA Gamma Pool Facility. ---Page Break--- AGRICULTURAL B 10-SCIENCES DIVISION Tre Agricultural airec ng ABPSeUltArAL BioSciences Division tua save' Sr iu dlgPeetts Raton nt ney water Division Cr epuPointed Program Director of te Weecey htt tine Director of Sufcttional Science Pouniatien tea'getees Boloay Pereenee ERIC? Aemuted interim direction Mfr dimes, MET} Genter." the Universiey cePace, te both Inboratoriee of the Mrelenes 17 oe Rts Wek borate of the Reh ral Bxperient in Mayaguez. The U-S. Departaent of Agriculture operates an Expericent Station in

Mayagüez, Educa' through this distant WUusatsonal opportunities available to students THESIS RESEARCH FOR M.S. DEGREE IN BIOLOGY Courses for the B.S. Degree in Biology Health Physics, Introduction to Bio-Physics, clear Techniques of Biological Research, Marine Applications in Nuclear Science, Atomic and Nuclear Physics, and General Cytology. The required thesis may be done at the Nuclear Center on a problem of mutual interest to the graduate student and his faculty advisor. Research in Biology, Radiobiology, Marine Biology, and Entomology are described in this report. MECHANISM FOR RADIATION-INDUCED BACK MUTATION Dr. F. K. S. Koo Back mutation can be attributed either to a true reverse mutation at the mutated locus or to a suppressor gene that arises through mutation at a locus other than the mutated one. With the present knowledge of the fine structure of genes, the structure of the DNA molecule, and the amino acid sequence in some proteins, one may envisage another mechanism of back mutation; i.e., a process by which an impaired functional unit is restored to normal function by replacing a damaged unit with an identical or similar non-damaged one. The restoration through this mechanism can be achieved only by interchanges between the same areas of homologous chromosomes or sister chromatids where breaks have been induced by irradiation treatment. The replacement may occur (1) a single nucleotide pair; (2) a group of nucleotides; the levels of: (1) a single nucleotide(s) a cistron. This mechanism is free specifying an amino acid; it raises the possibility of the existence of repeats of the same nucleotide sequences, for a group of nucleotides and cistrons. The probability for two to control a single regulation at suitable positions for a variation ---Page Break--- interchange is small but by no means zero. A mis-replacement of the damaged genetic material might lead to a restoration of function as well. It is known that, in some cases, a modified protein enzyme with '@

changed amino acid sequence performs a function not recognizably different from that of a normal enzyme. On the assumption that repeats exist at different levels in the genetic material, a mutation may be induced by impairment or loss of one of the members in the repeat and a back mutation by

adding an identical member back through interchanges between homologous chromosomes or sister chromatids. This working hypothesis is to be tested by using yellow-green mutants of *Oryza sativa* in which normal green stripes representing back mutation events are expected to be detected in leaves following seed irradiation. Since back mutation in this test system presumably involves interchanges between sister chromatids, chromosomes must first be induced into a bipartite condition before being irradiated. The first phase of the program, i.e., induction of mutations, is being carried out with the aid of gamma and neutron irradiation. This study may also shed light on the nature of gene structure in higher plants.

STUDY OF THE RADIATION EFFECTS ON STIMULUS TRANSMISSION AND PULVINUS SENSITIVITY IN MIMOSA PUDICA Dr. F. K. S. Koo This species appears to be relatively resistant to permanent damage by gamma radiation. The initial damage to stimulus transmission was more severe at all dosage levels than the damage to pulvinus sensitivity. At 50 Kr some reversible damage occurred. The speed and degree of recovery of stimulus transmission and pulvinus sensitivity appeared to be negatively correlated with radiation dosage.

ACTIONS OF 5-BROMOURACIL DEOXYRIBOSIDE (BUDR) ON PLANT CHROMOSOMES Dr. F. K. S. Koo BUDR is a well-known radiosensitizer in cell killing. In the present study with chromosomes in *Zebrina pendula*, *Rhoeo discolor*, and *Allium cepa*, several additional aspects of BUDR action have been revealed: (1) It induces breakages more readily at centromeres than at other chromosome regions. (2) It often prevents the contraction of the secondary constrictions while the other chromosome regions usually contract under the influence of

p-dichlorobenzene. (3) It produces breakages directly (without incorporation) in the chromatids in addition to its chromosome-breaking action through incorporation. (4) In combined treatment with gamma rays, it interacts with radiation to increase chromosomal aberrations, resulting in a synergistic effect. These aforementioned actions appear to involve different mechanisms. ---Page Break---

INHIBITION OF R_a 1 Bry RONORS J. Teas! with Weve BANANAS, BY GAMMA RADIATION Campos: Cuebas Quintana and Joaquin Oliver Unripe bananas of gamma, radiated varieties of Johnson and Monte Cristo were stored at room temperature. The ripening speed of both varieties was retarded to approximately 0.5 Kr; the maximum effect on ripening was retarded by ten days, while some with higher doses caused early blackening of the skin. Either 2 minutes of acid could be reactivated in the irradiated fruit by exposing to ethylene gas. The use of radiation allowed the fruit to be treated at any time by the possibility of maintaining possible economic management of staleness.

ACEROLA METABOLISM - Dr. Andrew Marezkt Injection of acerola fruit sent with uniformly grown fruit during the earliest stages of development showed detectable uptake of radioactivity by ascorbic acid. Similar results were observed with the uptake of these radioisotopes in acerola through the leaves. Conversion to ascorbic acid was not detectable in fruit slices incubated with the above-mentioned precursor for periods of 5 minutes to 3 hours, or with acetate labeled in either the carboxyl or the methyl group carbon. These negative results suggest the possibility that a pathway of biosynthesis is operative, different from that observed in cross seedlings, mung beans, and strawberries. Extension of these investigations to fruit slices incubated with C¹⁴-bicarbonate resulted in interesting labeling patterns. A very small amount of radioactive

Ascorbic acid was formed under these conditions. Considerable conversion into carbohydrates and organic acids took place. These conversions appeared to be triggered only partially by photosynthetic mechanisms. Either studies showed a remarkably higher rate of formation of one of the traveled substances than that calculated for the other major composite. This substance behaved chromatographically very similar to citric acid. Experiments to complete the identification of the unknown substance are still in progress. The information available at this time confirms it is a polycarboxylic acid with a neutralization equivalent of 90 and apparently different from any of the

organic acids which commonly occur in plants. During the investigations, work continued on the isolation and identification of biological antagonists from marine algae. A dinoflagellate from which we had previously isolated acrylic acid inhibited the gram-positive bacteria, and a high molecular weight substance, which inhibited yeast growth, was found to concern also a neurotoxin. This is related to the shellfish poisons. Further work is in progress on the purification of the toxin and on the isolation of larger quantities of the yeast inhibitor for degradation studies. AUTOMATIC ANALYSIS OF THE SUCROSE CONTENT OF SUGARCANE ~ Dr. R. A. Luse As background for proposed studies on sugarcane mutants, experiments have been done to test the feasibility of analyzing for sucrose content in hundreds or thousands of plant tissue samples. Application of the Technicon Auto-Analyzer for this mass screening has been shown to be reasonable, since nearly 500 samples may be analyzed per day, with minimal operator attention. Over 1500 samples of sugarcane extracts have been analyzed during preliminary experiments designed to show variability of sucrose levels within a single plant and between several plants. Current studies are being carried out on sugarcane seedlings and leaf tissue to find whether or not there is correlation.

between early sucrose levels and sugar yield in the mature plant. NEUTRON INDUCED HIGH-SUCROSE MUTANT Dr. R. A. Luse The above studies will be combined in a more general research program to be carried out on a co-operative basis by investigators from PRNC and the Agricultural Experiment Station. In this program, the biochemistry of those sugarcane mutants produced by neutron seed irradiation which show high sucrose content will be investigated. Levels of enzyme which play a part in the biosynthesis of sucrose will be determined on those sugarcane plants with high sucrose (as shown by the mass screening). Such a program is expected to shed considerable light on the enzymology of sugar formation in sugarcane. PARAMUTATION - Dr. Duane B. Linden Genetics regulatory systems which control gene mutation are being investigated with major emphasis being given to the paramutation system as it occurs in maize. The nature of the regulator and its product as well as the type of alteration that is produced are the problems to be solved. Radiation treatments of the components of the system have indicated that the type of change which occurs in this system is an inactivation process rather than a true mutational event. Experiments were designed to determine whether the paramutation inducing process has a radiosensitivity similar to gene mutational events. The source inducing the paramutation change (Ret and Fe) and the site of action (RT) were each tested. ---Page Break--- 3L ev wore cut one day naa Procedure was similar for all groups. Tassels Fey evolved ot ion efít poinatpinl th fins. felling day." the tassels bene ued sete nate fe Soatipitie taser (ie Be ee eat eset crue te to x8 r® stock, using the ré r8 as fenaie. meee When the site for paramutants crone te", the tation change was irradiated before crossing to BOF or EA approximately 10h of the time (10 out of 170 sags) th 0 apparent paramutation, (i.e. the testeross ears were 204 dark purple). In addition there is evidence that there is some St the cara'y preyugual

paramutation interaction in 15-204 of the rest of the cars. 'appear to have either a reduced paramutational change or are segregating for paramutation alteration on the ear traces back to a single irradiated pollen grain. When the R5t stock was irradiated prior to crossing: O and testcrossed GU of the line there was no apparent effect. There were no ears that were 50% dark purple (i.e. no paramutation), however 236 of the ears had light spotted and dark spotted seed predominate with very few yellow and some dark purple kernels. There was a definite effect on the paramutation interaction but probably no instance of complete inactivation. The remainder of the ears are in a suspect category with light spotted predominate and some dark mottled of full purple seed, very few yellow. 'The ears appear to be significantly different from the majority class which had light spotted and full yellow seeds predominate. The final group involved irradiation of the HY

with subsequent testcrossing identical to R5t. Here there was 5% apparent complete inactivation of the paramutation interaction (i.e. ears were 50% dark purple). A reduced paramutation effect is more difficult to detect in the marbled induced change as the variability is greater. There was no effect on the paramutation interaction or perhaps some with reduced effect in BY of the ears. The other 9h of the ears have what appears to be an increased paramutation expression. The seeds are predominantly yellow and light spotted with no very dark mottled and no full purple seed on the ears. 'The altered RT seed appear very similar to the R° from R8t induced paramutation change. This would indicate that the Hib source has some mechanism which inhibits full induction of the paramutation alteration. RADIOECOLOGY OF A TROPICAL RAIN FOREST, TERRESTRIAL ECOLOGY PROGRAM, PART I (supported by USAEC Division of Biology and Medicine) Santa this program was started under the direction of Dr. Howard 2. du as to be. The objectives of determining effects in the spring.

of 19:2, rain forest and the movement of soil elements in the normal chemical cycles occurring in a rain forest. An area in the Luquillo Forest Reserve was provided by the U.S. Forestry Service and studies were initiated on the normal pattern before irradiation. The area was developed with trails, instrumentation, electric power, and work facilities. A new staff has begun measurements. Some specialists were brought in from universities in the mainland for short periods. A ten thousand curie Cesium source will be brought into the area around January 1965 for irradiation of about three months. Studies of effects produced will follow to match those made prior to irradiation. MARINE BIOLOGY PROGRAM (supported by USAEC Division of Biology and Medicine) This program is under the direction of Dr. Frank Loman. The acquisition of equipment began in February 1962 and on July 3, 1962, a 100-ton ship, belonging to the U.S. Army, was delivered to San Juan, Puerto Rico by the U.S. Coast Guard. The vessel was named the "Shinada". Five basic areas of research have been proposed: MEASUREMENT OF MARINE PRODUCTIVITY BY MEANS OF C14 AND OXYGEN METHODS This phase has been delayed until our research vessel is completely equipped, since water samples must be taken at sea and the analysis must be done at sea to measure productivity. DETERMINATION OF SELECTED STABLE ELEMENTS IN MARINE ORGANISMS, WATER, AND BOTTOM SEDIMENTS In the analytical techniques used until now, the majority of investigations have been done using the technique of activation analysis. Samples of marine origin are difficult to analyze for trace elements by any technique due to the large amounts of NaCl present. Activation analysis methods have been developed for analyzing the following trace elements: Scandium, Silver, Vanadium, Manganese, Cobalt, Selenium, and Iodine. All elements selected for activation analysis with the exception of iodine may be coincidence counted. The coincidence counting results in the exclusion of counts other

than those of the desired isotope, so that less rigorous chemical separations may be used than if ordinary gamma spectrometry were used. ---Page Break--- The Shimada Communications and Loran Equipment ---Page Break--- Carbon nitrogen oxygen analysis of marine specimens ---Page Break--- DETERMINATION OF CONCENTRATION OF ORGANISMS WITH SELECTED RADIOELEMENTS IN MARINE The uptake of radioactive scandium and ruthenium by marine organisms has been investigated. Organisms were maintained in a closed system in which water had been irradiated and temperature was controlled by pumping from a large reservoir. Contrary to the experiment in which these organisms were held in small volumes of contaminated water, the uptake of both radioactive elements was not high and proceeded at a very slow rate. At the end of two weeks, the concentrations had not reached an equilibrium state. Results obtained by other investigators using small volumes of water showed that equilibrium is reached in as little as four to eight hours. The explanation may lie in the fact that with a small volume of water the organism

takes up all the radioactive elements present and then reaches equilibrium. MEASUREMENT OF RADIOISOTOPES NOW PRESENT IN MARINE ORGANISMS, WATER AND BOTTOM SEDIMENTS This work is well underway and rainwater samples were collected and analyzed. The following isotopes have been found in rainwater samples: Ce144, Pr141, Ru106, Nb95, Cs137, and Ba137. Sr90-Y90 separations were made using a combination of nitric acid precipitation and ion exchange separations. Biological specimens of the following types have also been analyzed: terrestrial plants, marine algae, marine angiosperms, and marine invertebrates. Results to date: in terrestrial plants no Cs137 was detected which is contrary to expectations. In marine algae only Zr95, Nb95, Ru106, Rh106, and K40 were found. It was expected to find Ce144, Pr141, Co57, Co60, and Zn65 on the basis of findings in the Pacific Proving Ground. COLLECTION OF BACKGROUND OBSERVATIONS IN PHYSICAL AND CHEMICAL

OCEANOGRAPHY TO BE USED IN INTERPRETING DATA COLLECTED IN THE FIRST FOUR PROGRAMS As of the end of the period covered by this report, this part of the program was being activated. In addition to the programs mentioned above, the Marine Biology group was asked to study the off-shore area at the BONUS reactor site for background data to be used in case of an accidental release of radioactivity through the salt water cooling system of the reactor. ---Page Break--- This was accomplished using a Rhodamine-B fluorescent dye that is magenta in color and has a peak fluorescence at approximately 66700 millimicrons when excited with ultraviolet light. The dye does not complex with beach or organic surfaces and is easy to see and photograph at dilutions of at least one part in ten billion parts of seawater. RESONANCE IN RADIATION EFFECTS PROGRAM Drs. H. J. Gonberg, R.A. Luse, and F. Vazquez Martinez Experiments using monochromatic x-radiation in the energy range 6.4 ~ 8.3 Kev have shown increased inactivation of the metalloenzyme catalase at or near the K-absorption edge of iron (7.11 Kev). This is taken to confirm the resonance radiation hypothesis of Gonberg and previous experimental work of Ennos and Paraskevoudakis. X-radiation intensities have been measured in the sample holder with a Fricke ferrous ammonium sulfate dosimeter. A more sensitive method for detection of the ferric ion produced has been developed using the ferrithiocyanate complex. The x-ray emission system utilized for the present resonance radiation studies has been characterized quantitatively as to intensity and photon energy distribution and second harmonic contamination. The monochromatic x-ray beam resulting from crystal diffraction and collimation was analyzed horizontally across its front for (a) intensity distribution, utilizing a special moving slit device; and (b) photon energy distribution, using double diffraction by a second analyzer crystal. Estimation of the extent of second harmonic energies was made from (a) absorption

measurements relying on the different mass absorption coefficients at the first and second harmonic wavelengths and (b) double diffraction measurements in which photons with second harmonic energies were analyzed separately. Correction for the percentage of reflection by second harmonic energies also was determined by the double diffractometer method. Contamination by higher harmonics was shown to be considerable at higher operation voltages; monochromatic beams can be obtained only by proper selection of tube potential. The effects on the beam by varying the position of the various components in the x-ray system (tube, diffraction crystal, two collimator slits) were determined and the system was selected which provides high uniformity of photon energy distribution. As a result, a diffraction system was developed which permits irradiation with photons of uniform energy distribution (only 50 eV in 6-9 keV). ---Page Break--- NUCLEAR SCIENCE AND TECHNOLOGY DIVISION This division and points of vision concerns itself with graduate students and Rivets interested in specializing in the nuclear science. THESIS RESEARCH Fi serence RRS RCH GORA THE M.S. DEGREE IN NUCLEAR science topics are

stated in the core curriculum; radiological engineering, materials science; Nuclear Engineering research topics include the following electives: Reactor Instrumentation and Control, Reactor Metallurgy, Chemical Processing of Nuclear Fuels, Nuclear Measurements and Instrumentation, Quantum Theory, Radiochemistry, and Servo Mechanisms. The topics include THESIS RESEARCH FOR THE M.S. DEGREE IN CHEMISTRY The following topics are included in the required curriculum for the course: Advanced Inorganic Chemistry, Advanced Organic Chemistry, Nuclear Chemistry, Advanced Radiochemical Techniques, and Nuclear Measurements and Instrumentations. Among the electives available are the following: Mathematics of Modern Science, Advanced Inorganic Chemistry, Radiochemistry, and Health Physics. The required thesis research may be done at the Nuclear Center and

is based on a scientific problem of mutual interest to the graduate student and his advisor from the Nuclear Center staff. THESIS RESEARCH FOR THE M.S. DEGREE IN PHYSICS the following courses are available to the graduate student in Physics: Classical Physics, Introduction to Theoretical Physics, Nuclear and Reactor Physics, Mathematical Physics, Introduction to Physical Statistics, Atomic and Nuclear Physics, Introduction to X-Ray Diffraction, Introduction to Quantum Theory, Introduction to Neutron Physics, Methods of Theoretical Physics, Interaction of Radiation with Matter, and Introduction to Celestial Mechanics. The required thesis research may be done at the Nuclear Center and is based on a problem of mutual interest to the graduate student and his advisor from PRNC. ---Page Break--- Under the direction of Dr. Owen H. Wheeler the research in organic chemistry is as follows: SYNTHESIS OF SUBSTITUTED STILBENES with H. Battle Synthetic methods for preparing cis- and trans-stilbenes are being compared. The ultraviolet and infrared spectra and polarographic reduction potentials will be measured in relation to the effects of substituents. The spin-spin hydrogen coupling in the cis-stilbenes is being measured in conjunction with the Instituto de Quimica of the Universidad Nacional Autónoma de México. RADIATION CHEMISTRY OF STEROIDS with R. Montalvo The effect of gamma radiation on estrone and its derivatives is being studied in relation to the mechanism of hydroxylation of these compounds. Comparison will be made with the effect of x-rays and of chemical radical hydroxylation. STEROID DERIVATIVES OF RADIOLOGICAL INTEREST with C. Reyes Derivatives of corticosteroids incorporating boric acid in the side chain are being prepared as neutron absorbers. Other derivatives incorporating sulfur compounds in ring D or the side-chain will be prepared as possible radiation-protecting drugs. MECHANISM OF THERMAL REARRANGEMENTS with I. Casanova The postulated intramolecular nature of the Chapman rearrangement of phenyl

Benziminio ethers are being checked using Carbon-14 labelled compounds. The allied rearrangement of the corresponding allyl ether will be studied using tritium labelling. DEUTERIUM ISOTOPE EFFECT IN THE ETARD REACTION The nature of the rate-determining step in the etara oxidation of toluene with chromyl chloride is being investigated using methyl-deuterated toluene. ---Page Break--- NEUTRON DIFFRACTION PR Research). Dr. Tensei Almodóvar, PR WEOEt by Usaze National Laboratory, Dr. Helmet' Berd Okada (Japan) SESE Division of ners Frazer (Brocsaeny cf Germany), and Dr. Kenkiens, With the present shielding, it is estimated that the facility can operate safely at reactor power levels up to ten eons. Preliminary diffraction data are now being collected from a natural mineral sample of fayalite (Fe_2SiO_4) in preparation for later low-temperature magnetic structure studies. The first problem expected to be completed on the spectrometer is a single crystal structure analysis of calcium tungstate (the mineral scheelite). This structure was examined many years ago using X-rays, but reliable oxygen coordinates could not be obtained because of the intense tungsten scattering. Work on the structure will commence upon the arrival of Dr. Mortimer Kay. Dr. Kay, of the Georgia Institute of Technology, collaborated with Dr.

Almodóvar and Dr. Frazer on this problem. Subsequent research will fall into two general areas: the structural role of hydrogen in hydrogen-bonded crystals, and the magnetic spin structures of transition metal compounds. Some sample preparation work is now in progress for these later studies. MODIFICATION OF THE THERMAL COLUMN IN THE PUERTO RICO NUCLEAR CENTER REACTOR - Dr. John A. Wethington (University of Florida) with Orlando Angleré in the cylindrical access position of the graphite.

theraal column 48 a convenient place for wet exponential experiments if a suitable source condition can be achieved. The exponential decrease of neutrons across the bottom of this access, when the column is low graphite, validates its use for such experiments. General column assembly in the area on note. Various even the 20st 5 removed from the Zone graphite was gravity or neutrons in order to create a graphite lined configuration. Configurations of reflectors were tried in order for symmetrical flux distribution at the bottom. It has been shown that the void pattern selected does give a suitable source condition. The flux data are being fitted with both cosine and Bessel functions in order to establish the best equations for neutron flux as a function of space coordinates. In addition to the improvement in flux shape, the use of the cavity increases the absolute neutron flux by one decade in the vertical access position and by three decades in the horizontal access position. RADIATION EFFECTS IN FLUOROCARBONS - Dr. John A. Wethington with P. Rosa González The effect of reactor radiation on fluorocarbons is an unexplored field. Samples of CyPy35 (CyPg)3N, and C-C3Py60, supplied by the Minnesota Mining and Manufacturing Co., are being distilled in order to obtain known fractions for the determination of physical properties. Physical properties will be studied as a function of radiation dose. CERIC DOSIMETRY - Dr. Fausto Muñoz Ribadeneira with Milagros Miré Villerini Ceric sulfate has been widely used as an efficient chemical dosimeter for doses up to 10^3 Rad, but difficulties related to chemical purity and water quality make its use problematic due to the erratic "g" value changes from one determination to another. The "G" values found by the ceric-cupric system are reported as follows: "G" VALUES CERIC-CUPRIC SYSTEM cut Concentration Barnstead Tri-Distilled Normality water Water 0.0 2.78 0.21 2.51 0.03 1.000 0.001 2.57 0.430 2.50 0.03 1.002 0.01 2.54 0.09 2.47 0.01 1.0006 0.22 0.02 2.22 0.01 0.0531

f = correction Factor ---Page Break--- u Inspecting the values obtained say that the increase in copper concentration reasons the mean value and at the same time produces good "c" values. Water solutions, the "o" corresponding values are situated in a range of 0 to 1×10^0 , are in a copper several reports, also being very stable. For copper concentration $\{^\circ\text{C}$ for both solutions prevent a "0" which as ERe actions of magnitude and limit of error. A true explanation of the physical chemistry of the copper & sin enc being tied and compared to eliotig oo Ge (is0u)3 are being used. Results are being tested with a PRNG 2000 curie cobalt source. The RADIATION EFFECTS IN THE THERMAL EMISSIVITY OF GRAPHITE Professor Richard B. Knight (North Carolina State College) and Professor K. Soderstrom with Mr. Guillermo Rodriguez Figueroa. An apparatus consisting of a cylinder of graphite in an evacuated aluminum housing has been constructed and mounted in one of the beam tubes. The changes in the thermal emissivity of the graphite due to neutron bombardment are being studied by measuring the heat loss of the graphite to a flow of cooling water in the outer jacket, on heating the inner surface of the graphite. FERROELECTRIC PROPERTIES OF TRIGLYCINE SULFATE CRYSTALS - Dr. Julio Gonzalo González with Juan López Alonso the ferroelectric hysteresis behavior of crystals of triglycine sulfate is being studied over a range of frequencies and at ambient and two temperatures. The effects of x-ray and gamma radiation will be studied. THE MINIMUM CRITICAL DETERMINING A GRAPHICAL METHOD FOR DETERMINING THE MASS OF A BARE HOMOGENEOUS REACTOR — Anneliese Kraft de

Pérez. The minimum critical mass of a bare homogeneous reactor can be calculated from the critical mass equation. The tedious process of point by point plotting to find the minimum mass from the eye obtained for each fuel-moderator system demonstrates finding a more simple method. The critical results in a

transcendental equation and a convenient transform (C41) which has only a grapher given by the intersection of two functions; ---Page Break--- 4 Line whose direction depends only on the nuclear parameters of the moderator and an exponential function which depends only on the average number of fast fission neutrons emitted as a result of the capture of one thermal neutron in the fuel. The graphical method in general leads immediately to the minimum critical mass for spherical, cubical, or cylindrical shapes of reactors for any moderator in combination with U²³⁵. HIGH ENERGY GAMMA PHOTON-NEUTRON CONVERSION DEVICE FOR HALF LIFE MEASUREMENTS - Dr. Eddie Ortiz with J. Facetti and S. Pinto Vega 'The basic principle involved is the disintegration of deuterium by high energy gamma photons to produce fast neutrons which are moderated by an optimum thickness of paraffin to get the best balance between moderation and capture and then the neutrons are detected by a BF₃ counter. 'The half-lives of ⁹⁹Tc, ¹³⁷Cs, ¹³⁹La, and of fission products from U²³⁵ fuel elements have been measured. Fission product decay has been measured using the fuel elements from the PRIC Swimming Pool Reactor and by separate irradiation of uranyl nitrate. The arsenic sample showed a 3.66 min. activity in addition to the expected 26.8 hr As activity. Experiments are now in progress to identify this presumed new activity. THEORETICAL AND EXPERIMENTAL STUDY OF FATIGUE IN PHOTOMULTIPLIER TUBES - Rev. Ignacio Cantarell In spite of the widespread use of photomultiplier tubes for precise measurements, there exists a difficulty which has not been overcome and which continues to distort the measurements made with them. This difficulty is fatigue which is reflected in the abnormal variation in the gain with time.

Explicit brochures from phototube suppliers attribute the fatigue to cesium migration and comment that this phenomenon is not fully understood. Before 1958, only a few qualitative and semi-quantitative studies had been made and the causes of fatigue remained unexplained. It was decided to carry out a systematic quantitative and qualitative study of fatigue in multiplier phototubes. The variables which affect the phenomenon of fatigue were first determined: These were found to be: (a) working time, (b) rest time, (c) history of previous use of the tube, (d) intensity, (e) intensity and nature of applied voltage to the anode, (f) nature of anodes and (g) tube. The principal variable was time, since it influences the fatigue, and has an effect which cannot be experimentally measured. Studies were later performed on the dependence of relative section to the other variables. ANNEALING EXPERIMENTS IN NEUTRON IRRADIATED COMPOUNDS - Dr. J.F. Facetti with E. Trabal and S. Torres Antimony-III and -V compounds were submitted to thermal annealing after neutron irradiation. The samples were analyzed by extraction with isopropyl ether and measured with NaI (TI) crystal coupled to a multi-channel pulse height analyzer. The products of this type of Szilard-Chalmers process show annealing response similar to other oxyanions and oxides studied. DISTRIBUTION OF RADIOACTIVE ANTIMONY FORMED BY NUCLEAR TRANSFORMATION IN ANTIMONY OXIDES - Dr. J. F. Facetti with B. Trabal and S. Torres Antimony oxides were irradiated with neutrons in the PRNC nuclear reactor, to study the distribution of radioactive Sb-124 and Sb-125 between the tri and pentavalent oxidation states. Antimony (V) was extracted with isopropyl ether. The radioactive samples were counted in a NaI (TI) well crystal coupled to a multi-channel analyzer. The results show a linear relation between the

composition of oxide and the percentage of radioactive Sb-125, similar to that obtained by other workers with arsenic oxides.

Adjusting a specimen on the Neutron Spectrometer ---Page Break--- US HEALTH PHYSICS DIVISION The primary function of this division is to establish and carry out a program guaranteeing the safety of the Puerto Rico Nuclear Center. The safety of all personnel working at the Puerto Rico Nuclear Center is paramount. The research laboratory in this area was conducted under the direction of Dr. Jorge Ferrer Monge. The project is kept current by continuous data gathering. A graduate program leading to the M.S. Degree in Health Physics is approved by the US-ABD Special Fellowship Program administered by O&185. Educational opportunities offered by this division include: THESIS RESEARCH FOR M.S. DEGREE IN HEALTH PHYSICS The graduate program in Health Physics includes the following courses: Radiological Safety, Radiobiology, Radiological Electronics, Atomic Physics, Nuclear Measurements and Instrumentation, Radiochemistry, Nuclear Techniques in Biological Research, Mathematics of Modern Science, Advanced Radiochemical Techniques, Nuclear Chemistry, Health Physics, and Biological Oceanography. The required thesis research may be done at the Nuclear Center on a problem of mutual interest to the graduate student and his FRNC advisor. SURVEY OF BONUS REACTOR SITE An ecological and environmental survey of the BONUS Reactor site in Rincon, Puerto Rico, is continuing. The general purposes of this project are to provide data on radioisotopes now present in the area, and useful data for the Marine Biology and Oceanography Program of PRNC under the direction of Dr. Frank Loman. The project is divided into five parts: (1) survey of data, (2) determination of present radioactivity levels and composition of soil, rocks, water, air, and biota, (3) determination of stable element composition of biota, (4) collection of background data and evaluation of plumes (and topographic factors related to meteorological, hydrological, and ecological conditions), (5) integration.

of the data related to a possible reactor accident. ---Page Break--- FUNDAMENTALS Bonus Power Reactor ---Page Break--- REACTOR DIVISION The division operates and maintains Mayaguez: a 1277 Homogeneous Reactor and a mid pool tree green reactor designed for operation at 5 megawatt power levels. This includes the operation of the hot cells, gamma irradiation facilities and shops. In addition, it is responsible for the maintenance and operation of the physical plant and the meteorological station. It provides reactor and associated facilities for research. The PRNC Research Reactor is operated at its authorized power level of 1 megawatt. Modifications have been made to correct defects and improve operation. Control rods have been calibrated, new core configurations have been studied in which the control rod worth has been improved considerably and in which all control rod interaction has been eliminated; neutron flux mapping of the cores has been done and in general a complete determination of reactor parameters has been made. An expanding research program utilizing the reactors is developing. Two of the beam tubes of the reactor are now being utilized full-time. A neutron spectrometer has been installed in one and the Thermal Emissivity of Graphite Research Apparatus has been installed in another. A second larger neutron spectrometer was installed in a third beam tube. The Reactor Division has trained reactor operators for the new power reactor being constructed in Rincón, Puerto Rico which will be operated by the Puerto Rico Water Resources Authority for the U.S. Atomic Energy Commission. REACTOR SUPERVISOR TRAINING This course is based on individual needs and interests. The trainee becomes acquainted with the electrical, electronic, and mechanical equipment associated with the PRIC research reactor. He learns the roles and regulations governing operating procedures and becomes acquainted with and performs the duties of a reactor operator. Techniques and procedures for the irradiation of samples are demonstrated.

strated and reviewed as well as the techniques for the preparation of sere tetux mappings, neutron distribution and fuel burn-up calculations The routine maintenance problems of reactor equipment and components are retained as well as the basic problems of safe reactor operation, ---Page Break--- remainder of the Control room for research reactor currently operating at one megawatt power level ---Page Break--- NUCLEAR ENGINEERING DIVISION ARCH FOR M.S. DEGREE IN NUCLEAR | and bridge from which the reactor core is suspended. « Research reactor Control room is visible in the background, ——— ---Page Break--- APPENDIX ---Page Break--- SCIENTIFIC John C. Bugher, Director M.D., University of Michigan Pathology. Henry J. Gonberg, Deputy Director Ph.D., University of Michigan Physics Amador Cobas, Associate Director Ph.D., Columbia University Physics Ismael Almodévar, Head Neutron Diffraction Program Ph.D., Carnegie Inst. of Technology Chemistry Héctor M. Barcel, Head Reactor Division M.S., University of Puerto Rico Nuclear Technology José A. Ferrer Monge, Head Health Physics Division Ph.D., Louisiana State University Biology José Luis Garcia de Quevedo, Head Nuclear Engineering Division Ph.D., Duke University Physics 53 STAFF Sergio Irizarry, Head Clinical Applications Division M.D., University of Buffalo Internal Medicine Frank Lowman, Head Marine Biology Program Ph.D., University of Washington Marine Biology Victor Marcial, Head Radiotherapy & Cancer Division M.D., Harvard University Radiology Howard T. Odum, Head Terrestrial Ecology Program Ph.D., Yale University Zoology Eawin Roig, Head Radioisotope Applications Div. Ph.D., Pennsylvania University Chemistry Paul Weinbren, Head Medical Sc. & Radiobiology Div. M.D., LRCP, Witwatersrand Univ. Pathology, Owen H. Wheeler, Head Nuclear Sc. & Technology Div. Ph.D., University of London Chemistry ---Page Break--- oh Oriel Alva, M.D. University of Buenos Aires Radiotherapy Enrique Avile, M.S., University of Wisconsin Oceanography Helmut J. Blelen, Ph.D. University of Cologne

Inorganic Chemistry Antonio Bosch, M.D. Universidad Axténona de México Radiotherapy Richard Brown Campos, M.S. University of Puerto Rico Nuclear Technology Ignacio Cantarelli, Lic. University of Madrid Nuclear Physics Pedro Cruz González, M.S. University of Puerto Rico Países Baltazar Cruz Vidal, M.A. Harvard University Physics Maloolm Daniels, Ph.D. University of Durham Chemistry George Drevry, M.A. University of Texas Zoology Juan F. Facetti, Pa.D. University of Asunción Radiochemistry Zenaida Fries, M.P.H. University of Michigan Bio-Statistics Joaquin García de 1 Noceda, B.S. University of Puerto Rico Physics Jean García Rivera, Ph.D. University of Wisconsin Chemistry Norma I. González, M.S. Fordham University Biology Julio A. Gonzalo González, Ph.D. University of Madrid Physics Richard B. Knight, M.S. University of Illinois Electrical Engineering Francis K. B. Koo, Ph.D. University of Minnesota, Radiation Genetics Aldo B. Lanaro, M.D. University of Buenos Aires Nuclear Medicine & Endocrinology Duane B. Linden, Pa.D. University of Minnesota Plant Genetics Robert A. Luse, Ph.D. University of California Biochemistry Andrew Maretaki, Pa.D. Pennsylvania State University Biochemistry Raf McLin, M.S. University of Puerto Rico Physics Milagros Miré Vilarint, M.S. University of Puerto Rico Chemistry Fausto Muñoz Ribadeneira, Ch. Escuela Politécnica Nacional Chemical Engineering Margaret Nickle, M.S. University of Minnesota Bacteriology ---Page Break--- Kenkichi Okada, Ph.D. Kyoto University Physics Eadie Ortiz, Ph.D., Agricultural & Mechanical College of Texas Physics Heidi Pabén Pérez, M.A. University of Rochester Radiation Biology Maria M. Palacios de Lozano, M.S. University of Rochester Radiation Biology Kenneth Soderstrom, M.S.E. University of Florida Mechanical Engineering Juan J. Soltero, B.S. University of Puerto Rico Mechanical Engineering Robert A. Stevenson, Ph.D. University of Hawaii Marine Ecology H. Harry Semant, Ph.D. Purdue University Organic Chemistry José M. Tong, M.D. University of Zaragoza

'Therapeutic Radiology Jeanne Ubifias, M.D. Universidad Nacional Autónoma de México

Radiotherapy Florencio Vazquez Martinez, D.A.E.E. University of Madrid Physics John B. Villella, Ph.D. University of Michigan Zoology David Walker, Ph.D. Washington State University Entomology Barbara Weinbren, M.A.B.M.B.Cb. University of Oxford Biochemistry Carlos Wheeler, B.S.M.E. Case Institute of Technology Mechanical Engineering ---Page Break--- 57 Staff Publications 1958 - 1963 Aimodévar, I., and Truman Kohman, 'um Marine Sediments, ly, mortum Isotopes Method for Dating Marine based on Ph.D. thesis egie Insti Fe D. thesis at Carnegie Institute wro=-) and R.D. Macfarlane, Study of the Sml49 (n, OL) wal46 React: With thermal eutron, published in-Phyeiee feview 121, ES '(ise2), Physics Review Letter, July 1962. me 1 B.C. Frazer, H.J. Bielen, and M.J. Kay, Neutron Diffraction froiren (Progress Summary report fo. 1), published as FRIC-5, Bielen, H.J., et. al., Logarithmische Rechntafeln, published in the 93rd issue of the German Handbuch for Chemists, Pharmacists, Physicians, and Physicists (1962). , Ta. Hahn, W. Bysel, F. Weber, Struktur Polymorphic Mischkristall- 'Toilaing, Von Verbindungen des Phena Kittypts, Chemie der Erde 22, TP se Blanco de del Campo, M., Symposium on Endocervical Adenocarcinoma, published in Acta Cytologica, Vol. IV, No. 1, 2, 3 (1960). — Symposium: Training of the Cytotechnologists published in Acta Cytologica, Vol. IV, No. 1, SS --, Symposium on Effects of Progestational Agents, published in 'Acta Cytologica, Vol. VI, pages FTES OEE) Bonilla, F. (Former Director of PRNC), Fluid Flow in Reactor Systems (chapter 9-2), Heat Removal from Nuclear Reactors (Chapter 5-3), published in Nuclear Engineering Handbook, McGraw-Hill Book Co. New York (1958). Bosch, A. and Maj. W.L. Caldwell (Medical Corps, U.S. Army) Effects of Prolidothyronine in Altering the Response of Kidneys £9 eT ee paactogs Volr G1, To. %, October 1963. |, W.L. Caldwell, and Dr. R.W. Thomassen, Unfavorable Response of Radiation Nephritis

to Administration of Lafritodothyronine, published in Nature, No. 4863, January 12, 1563. Bugher, J.C., Book Review of Bentley Glass' Science and Liberal Education, published in Eugenics Quarterly, September 1961. ---Page Break--- 58 Bugher, J.C. The Puerto Rico Nuclear Center Research Reactor: Characteristics and Program Plans, published in Symposium on the Programming and Utilization of Research Reactors, Vol. 2, Vienna (1961). Yellow Fever, published in Encyclopedia Britannica, 1961 edition, pp. 683-684, Health Perspectives of Our Radioactive World, The First Annual Bronfman Lecture, published in American Journal of Public Health and the Nation's Health, Vol. 52, No. 5, May 1962. et al., Proceedings of Weapons Effects Seminar for Civil Defense, jointly sponsored by PRIC, ABC, and the Commonwealth Of Puerto Rico, published in November 1962. Canterell, I. and I. Almodóvar, Fatigue in Photomultiplier Tubes: Its Relationship to the Malter Effect, published in Trans, American Nuclear Society, Vol. 5, No. 1, 25 (1961). and C. Cusdrado, and I. Almodóvar, A Simple Device for the Automatic Elimination of Fatigue Effects in Photomultiplier Tubes published as PRNC-26, October 1963. and I. Almodóvar, Fatigue in Photomultiplier Tubes - An Effect of the Malter Type, published in Nuclear Instruments and Methods, No. 353, October 1963. and A. Macias, Time-Dependent Schottky Emission in Photomultiplier Tubes, Trans, American Nuclear Society, Vol. 6, No. 2, 18 (1963). and J.A. Gonzalo, Transient Radiation Effects on Electron Emission of High Resistivity Layers, Trans, American Nuclear Society, Vol. 6, No. 2, 305 (1963). Cobas, Anador and H.H. Szmant, Solid State Physics - Radiation Damage in Organic Crystals (Progress Summary Report No. 1), published PRNC-21 (July 1963). Daniels, M., Photochemically Induced Oxidation of Arsenite: Evidence for the Existence of As IV, published in Journal of Physical Chemistry, August 1962. Radiation Chemistry of Arsenite, Part II: Reactions in Oxygen-Free

Solutions, published in Journal of Physical Chemistry, August 1962, and A. Grimison, Photochemistry of Thymine, published in Nature 197, 484 (1963). ---Page Break--- 59 Facetti, J. Be treba, R, Re Moctin, published in Physical Review Letters, Suppl 4, 20, Distribution of Radioactive

Antimony Formed by Neutron Capture 33 Antimony Compounds, published as PRIC-29. Also published in Organic and Nuclear Chemistry, Vol. 25, pp. 759. Ferrer-Monge, J., Inheritance of Yield Component: Specific Points in an Interspecific Hybrid of Cotton, (Ph.D. Dissertation) Louisiana State University, Ecological Study of the West Coast of Puerto Rico (Progress: Summary Report No. 1), published as FANG-27, November 1953. García Benitez, C. and S. Wolff (of ORL), On the Increase of Sites for Chromosome Exchange Information After Colchicine Duplication published in Science, March 1966, (Work done at ORNL). García de Quevedo, J., The Puerto Rico Nuclear Center, published in "Revista del Colegio de Ingenieros, Arquitectos y Agrimensores de Puerto Rico" 9, No. 1, 4a (1959). Goldberg, H.J., J. Villella, and S.S. Gould, Corcariae Vaccine to Protect Against Schistosomiasis, published in Phoenix, Vol. 2, (work done at the University of Michigan). Tase, Resonance Radiation Effects of Low Energy X-rays on Shrouded Topas published in Radiation Research, Vol. 19, May 1963. Gonzalo, J.A. Research in Ferroelectrics, Thermal Hysteresis in Barium Titanate, published as PRNC-25 (October 1963). Neutron Isotope Effect in the Hydrogen Bonding of Grintgon, Oxy Deuterium published in Journal of Physical Chemistry, Vol. 7, 2 (1963) for Radiation-Induced Back Mutation, published Kooy F.K.S., A MOGRAIETT of Congress of Radiation Research, Abstract in Bee 234 (August 1962). of Papers, page by X-Rays and Thermal Neutrons in Caused Thermal Biological Effect, FTES! OF Avena, published in Radiation ---Page Break--- 60

Koo, F.K., Polygenic Variability Induced by Thermal Neutron Irradiation, published in Radiation Research, Vol. 16, p. 50 (Abstract) 1962. Action of S-Bromodeoxyuridine on Plant Chromosomes, published in Genetics Today, Vol. I, Proceedings of the XI International Congress of Genetics, The Hague, Netherlands, September 1963. Synergistic Effect of 5-Bromodeoxyuridine and Gamma Rays on Chromosomes, published in Science, July 19, 1963. Linden, D.B., Experiments Utilizing Radiation in a Paramutation Program, published in Maize Genetics Cooperation Newsletter, Vol. 36. Additional Sources in Paramutation Induction Ability, published in Genetics, Vol. 48, July 1963. Effects of Radiation on Paramutation, published in Radiation Research, Vol. 19, May 1963. Radiation Induced Modification of Paramutation Expression, published in Maize Genetics Cooperation Newsletter, Vol. 37, pp. 133-134 (1963); also published in Genetics Today, Vol. I, Proceedings of the XI International Congress of Genetics, September 1963 (The Hague, Netherlands). Survey of Some South American Races with Variegated Alurones for Paramutation Induction Ability, published in Maize Genetics Cooperation Newsletter, Vol. 37, pp. 134-135 (1963). Iowan, F. (a joint author), Disposal of low-level Radioactive Waste into Pacific Coastal Waters, publication 985 of the National Academy of Sciences and the National Research Council (1962). Mediterranean (Progress Summary Report Box), listed as PRIC-15 (1963). Jaws, B.A. and A.D. McLaven, Mechanism of Inactivation of Enzymes Proved by Ultraviolet Light, published in Science, Vol. 136, No. 3, pp. 036-037, September 22, 1961. Growth of Sterile Plant Roots in Sand or Soil in an Inexpensive Growth Chamber, published in Soil Science Society of America Proceedings, Vol. 26, No. 4, pp. 406-408, July-August. McCney and A.D. McLaren, Mechanism of Enzyme Inactivation by Ultraviolet Light and the Photochemistry of Nino Actas Cat 537. Published in the Journal of

Photochemistry and Photobiology, September 1962. (Work done at University of California, Berkeley, California.) ---Page Break--- A. Huse, R.A., Review of Recent Literature in Photobiology I, published in the Journal of Photochemistry and Photobiology, March 1962. Also, Review of Recent Literature in Photobiology and Photosynthesis, published in Journal of Photochemistry and Photobiology, December 1962. A.D. Mebaren and J.J. Skujins, Sterilization of Soil by Ultraviolet Light and Some Further Observations on Selectivity, Bacteriology Society of America Proceedings,

Vol. 371-377, July-August 1962, and A.D. Mebaren, Mechanism of Enzyme Inactivation by Ultraviolet Light and the Photochemical Effects, published in Photochemistry and Photobiology, Vol. 2, pp. 343-360, August 1963. Recent Literature in Photobiology and Photochemistry III, published in the Journal of Photochemistry and Photobiology, Vol. 2, pp. 73-79, 1963. Marcial, V.A., Panel Discussion on Mediastinal Tumors with Presentation of Cases, published in "Boletín de la Asociación Médica de Puerto Rico", Vol. 50, No. 10, October 1958. R.A. Marcial Rojas, B. Mirabal, R. Díaz Bonet, L.A. Díaz Bonet, "Atypical Tumors in Children" (Symposium with Presentation of Cases), published in "Boletín de la Asociación Médica de Puerto Rico", Vol. 51, No. 11, November 1959. Carcinoma of the Base of the Tongue, published in American Journal of Surgery 29 (1999). R.A. Marcial Rojas, P. Díaz Bonet, J. Davila Lopez, Santiago, Symposium on "Tumors of Bone", published in "Boletín de la Asociación Médica de Puerto Rico", Vol. 51, No. 2, February 1959. Cancer Morbidity in Puerto Rico, published in Acta Unio Internationales Contra Cancrum, July 1960. Socioeconomic Aspects of the Incidence of Cancer in Puerto Rico, published in Annals of the New York Academy of Sciences, December 1960. Carcinoma of the Penis, published in Radiology, August 1962. Our Cancer Problem,

published in 'Boletín de la Asociación Médica de Puerto Rico,' October 1962. ---Page Break--- 62 Marcial, V.A., O. García Ranfrez, and B.A. Forster, Two Years Experience in Comparative Cytology in Puerto Rico, published in "Boletín de la Asociación Médica de Puerto Rico," Vol. 54, No. 9, pp. 203-205, September 1962. =, J. Figueroa Colón, R. Marcial Rojas, and J.B. Colón, Carcinoma nis, published in the Medical Association Bulletin 3+ of the Pe 'Fanuary 1963. Maretzki, A. and M.T. Mallette, Nutritional Factors Stimulating the Formation of Lysine Decarboxylase in Escherichia Coli, published in Journal of Bacteriology, Vol. 83, No. 4, pp. 720-726, April 1962. Medina, J.V. and H.J. Teas, Fluorescent Compounds in Bf-1, published in Maize Genetics Cooperation Newsletter, 136e. , Fluorescent Metabolites Accumulated by a Mutant of Maize published in Maize Genetics Cooperation Newsletter, Vol. 37, pp. 135-136 (1963). Odum, H.T., R.J. Beyers, and N.E. Armstrong, Consequences of Small Storage Capacity in Nannoplankton Pertinent to Measurement of Primary Production in Tropical Waters, published in the Sears Foundation: Journal of Marine Research, Vol. 21, No. 3, September 15, 1963. » M.J. Copeland, and R.Z. Brown, Direct and Optical Assay of Leaf Mass of the Lower Montane Rain Forest of Puerto Rico, published in the Proceedings of the National Academy of Sciences, Vol. 49, No. 4, pp. 429-434, April 1963. -» R.J. Beyers, J. Larimer, R.B. Parker, N.E. Armstrong, Directions for the Determination of Changes in Carbon Dioxide Concentration from Changes in pH, published in Publications of the Institute of Marine Science, Vol. IX, pp. 854-889, December 1963. +) R.P. Cuzon du Rest, R.J. Beyers, and C. Allbaugh, Diurnal Metabolism, Total Phosphorus, One Anomaly, and Zooplankton Diversity of Abnormal Marine Ecosystems of Texas, published in Publications of the Institute of Marine Science, Vol. IX, pp. 53-53, December 1963. seen, W.B. Siler, R.J. Beyers, and N.B. Armstrong, Experiments with Engineering of Marine Ecosystems, published in

Publications of the Institute of Marine Science, Vol. IX, pp. 373-403, December 1963. - Limits of Remote Ecosystems Containing Man, published in The American Biology Teacher, Vol. 25, No. 6, October 1963, ---Page Break--- Cain, H.P., Productivity Measurements in Thalassia Testudinum: Effects of Dredging on Trophic Structure, Publications of the Institute of Marine Science, Vol. IX, pp. 130-158, December 1963. Okada, K., Photo-Micrographic Observations on X-Irradiated Rochelle Salt Crystals, published in the Tenth Symposium on the Chemistry of the Salt, No. 10, 613, October 1963. Ortiz, B., Student Method for Determining the Binding Energy of Deuteron, published in American Journal of Physics, Vol. 30, No. 20, An Inelastic Neutron Scattering Experiment, published in American Journal of Physics, Vol. 30, pp. 621-630. (September 1962)

Simple Experiments That Can Be Done with a Neutron Source, published as PRNO-DN. Palacios, Motley, Radioactive Waste Disposal, (Master's Thesis University of Cincinnati, June 1960). Roig, E., I. Rieckehoff, C. Russo, and J.D. Curet, Radioisotope Determination of Common Ion Effect on Solubility, published by Journal of Chemical Education, Vol. 38, page 350, July 1961. R.W. Dodson, The Thallous-Thallic Exchange at Various Acidities in Perchlorate Media, published in Journal of Physical Chemistry, Vol. 65, 2175 (1961). Smant, H.H., G.W. Miller, J. Mekhlouf, and K.C. Schreiber, Preparation and Properties of Trialkylfluorosilanes, published in Journal of Materials Science, 21, 2. Villella, J.B., H.J. Gonberg, and S.E. Gould, Immunization to Schistosoma mansoni in Mice Inoculated with Radiated Cercariae, published in Science, October 13, 1961. (Work done at the University of Michigan.) Wethington, J.A., Activation Analysis (análisis por Activación), published in Boletín Informativo, Comisión Nacional de Energía Atómica, Buenos Aires, Argentina, August 1962. Wheeler, O.H., The Girard.

Reagents, published in Chemical Reviews 62, 205 (1962). The Polarographic Reduction of Ortho-alkyl Nitrobenzenes, published in Canadian Journal of Chemistry, Vol. 41 (1963) page 92, (UPR), December 1962, Solvolysis of Some Substituted Glutaric Anhydrides, published in DSS Spanish Chemistry, 24, WMD, ANG (lez) (UE). ---Page Break--- Wheeler, O.H., and C.B. Covarrubias, Ultraviolet Spectra of Some Substituted Styrenes, published in Canadian Journal of Chemistry, 41, 1221. The work for this paper was done at the "Instituto de Química" of the Universidad Autónoma de Mexico. Electronic Spectral Data - Volume IV (to which Dr. Weccoe, Organic Chemist contributed), published by Interscience Publishers, New York, 1963. Oxidation of Substituted Anilines with Manganese Dioxide, Solvolysis of Some Substituted Glutaric Anhydrides, published in The American Chemical Society (1963). and C.B. Covarrubias, Ultraviolet Spectra and Polarographic Reduction Potentials of Some Cinnamic Acids, published in the Journal of Organic Chemistry, Vol. 28, 2015 (1963). Peter H. Grove, M. Santiago, and R. Béez Galib, Ultraviolet Absorption of Substituted Phenyl and Polycyclic Aryl Chalcones, published in Canadian Journal of Organic Chemistry. Research Activities at Puerto Rico Nuclear Center, published as PRNG-23 (September 1963). ---Page Break--- Participation in Scientific Meetings Author Dr. Amador Cobas Dr. Victor Marcial Dr. Angel A. Cintrón Rivera 21958 Title Plans for a Health Physics Training Program at the Puerto Rico Nuclear Center Cancer Morbidity in Puerto Rico Cancer in the Puerto Rican Woman The Importance of Cobalt Teletherapy in a Radiotherapy Department Cobalt Teletherapy in Cancer 1952 Hematology Vitamin B-12 Absorption in Tropical Sprue Serum Electrophoretic Patterns in 1,100 cases of Schistosoma mansoni Place Presented Symposium on Health Physics in Biology and Medicine- May, 1958 San Juan, Puerto Rico International

Cancer Congress - July, 1958 London, England Meeting of the Puerto Rico Medical Society - September 1958 San Juan, Puerto Rico Interamerican Congress of Radiology Nov., 1958 Lima, Peru Symposium on Health Physics in Biology and Medicine - May, 1958 San Juan, Puerto Rico 2nd Interamerican Atoms for Peace Symposium - May, 1959 Buenos Aires, Argentina Regional Meeting of the American College of Physicians - Oct., 1959 San Juan, Puerto Rico 56th Annual Meeting of the Medical Association of P.R. - Nov, 1959 San Juan, Puerto Rico ---Page Break--- Author Dr. Juan D. Curet, Dr. Victor Marcial, Inna Rieckehoff, Consuelo Russo, Dr. Juan D. Curet, Dr. Fred V. Soltero, Dr. Ismael Almodóvar, M.P. Kohman, Dr. I. Almodóvar, Rev. I. Cantarell, Dr. A.M. Andino, Dr. Arb. Rodriguez Title The Absorption of Gamma and Beta Rays by Weakly Paramagnetic Substances Cancer of the Tongue Cancer Control in Puerto Rico - Ten Years Experience The Demonstration of Chemical Principles by the Use of Radioisotopes Training in Radiochemistry in the Puerto Rico Nuclear Center 1960 The Thorium Isotopes Method for Dating Marine Sediments An Experimental Study of Fatigue in Photomultipliers A Practical Method for

the Compensation of Fatigue Effects Radioactive Iodine Treatment in Hyperthyroidism Place Presented 7th Latin American Chemical Congress April, 1959 Mexico City, Mexico 1st Latin American Cancer Congress October, 1959 Buenos Aires, Argentina 56th Annual Meeting of the Medical Association of P.R., Nov., 1959 San Juan, Puerto Rico 7th Latin American Chemical Congress April, 1959 Mexico City, Mexico 10th Latin American Chemical Congress April, 1959 Mexico City, Mexico Meeting of the American Chemical Society - September, 1960 New York Meeting of the American Chemical Society - September, 1960 New York Meeting of the American Chemical Society - September, 1960 New York 10th Annual Meeting of the P.R. Chapter of the American College of Physicians Oct., 1960 San Juan, Puerto Rico ---Page Break--- Author Dr. Victor Marcial Dr. Warren Miller

Dr. Eddie Ortiz Dr. A.L. Rodriguez Title Treatment of Cancer of the Tongue er of Socio-economic Aspects of the Cancer Incidence in Puerto Rico Beta Spectra with a Plastic Scintillator Instructional Laboratory Experiments with a Neutron Source Compton Spectra Experience with Dr. Ernesto Marchand Integration of the Dr. A.L. Rodriguez John C. Bugher Diodrast Renogram (a summary of the experience of 70 renograms) Serial In-Vitro Uptake of Fe-59 by Bone Marrow Suspensions in Different Hematologic States 362 The Puerto Rico Nuclear Center Research Reactor: Characteristics and Program Plans Presented Sectional Meeting P.R. Chapter of the American College of Surgeons- August, 1960 San Juan, Puerto Rico Conference on Society Culture and Health in the N.Y. Academy of Sciences- June, 1960 New York 29th Conference of the American Society of Physics Teachers- January, 1960 New York 29th Conference of the American Society of Physics Teachers- January, 1960 New York 29th Conference of the American Society of Physics Teachers- January, 1960 New York 10th Annual Meeting of the P.R. Chapter of the American College of Physicians- Oct., 1960 San Juan, Puerto Rico P.R. Medical Association Meeting- November, 1960 San Juan, Puerto Rico Symposium on the Programming and Utilization of Research Reactors- October, 1961 Vienna, Austria ---Page Break--- 68 Author Rev. I. Cantarell Fatigue in Photo- Dr. Ienael Almodéver multiplier Tubes and Dr. John C. Bugher Dr. Job. Garcia de Quevedo Dr. Henry J. Gonberg, Dr. Victor Marcial its Relationship to the Matter Effect Health Perspectives of our Radioactive World (the First Annual Bronfman Lecture) Education and Research Centers Fission, Fusion and Radiation Energy in a New Dimension Cancer of the Esophagus The Prognostic Value of Cytology in Cancer of the Cervix-Uteri Radiotherapy for Advanced Cancer: Cancer Control Program in Puerto Rico Cancer of the Tongue Carcinoma of the Esophagus Place Presented Meeting of the American Nuclear Society- June, 1961 Pittsburgh,

Pennsylvania 2nd General Session of the American Public Health Association, 89th Annual Meeting, Nov. 1961, Detroit, Michigan ABA, Regional Symposium on Education and Nuclear Energy - November 1961, Bariloche, Argentina Samuel Sackett Series of Lectures on Nuclear Energy - October 1961, Chicago, Illinois Annual Meeting P.R. Chapter of the American College of Surgeons - February 1961, San Juan, Puerto Rico 7th National Cancer Congress - 7th Radiological Workshop - August 1961, Bogotá, Colombia 7th National Cancer Congress - 7th Radiological Workshop - August 1961, Bogotá, Colombia American Roentgen Ray Society Meeting - Sept. 1961, Miami, Florida 7th Inter-American Congress of Radiology - September 1961, São Paulo, Brazil ---Page Break--- Author: Dr. Victor Marcial, (cont.) Mrs. Ima Rieckehoff Dr. A.L. Rodríguez Dr. Edwin Roig Title: Teletherapy Isotope Cancer Control in Puerto Rico, Twelve Years Experience Treatment of Cancer of the Tongue Cancer of the Esophagus Carcinoma of the Penis, Therapeutic Problems Common Ion Effect on Solubility - A Demonstration with Radioisotopes The Role of Calcium on the Intestinal Absorption of Vitamin B-12 in Tropical Sprue The Thallous-Thallic Exchange at Various Acidities in Perchlorate Media 7th Inter-American Congress of Radiology

September 1951, São Paulo, Brazil National Cancer Institute of Guatemala - November 1961, Guatemala City 12th National Congress in Medicine of the College of Physicians and Surgeons of Guatemala - November 1961, Guatemala City 11th National Congress in Medicine of the College of Physicians and Surgeons of Guatemala - November 1961, Guatemala City Annual Meeting of the Radiological Society of North America - Nov. 1961, Chicago, Illinois Caribbean Chemistry Conference - April 1961, University College of the West Indies, Kingston, Jamaica 2nd Annual Meeting of the University of P.R., School of Medicine - June 1962, San Juan, Puerto Rico Caribbean Chemistry Conference - April 1961, University College of the West Indies, Kingston, Jamaica

---Page Break--- 70 'Author Dr. HH, Szmant Dr. Howard J. Teas Dr. José M. Tomé Dr. Mario Vuksanovic Dr. J.A. del Regato Mr. Héctor Barcelé Dr. Antonio Bosch Dr. Malcolm Daniels Pr. Juan Facetti Title Chemistry in Latin America, Application of Atomic Energy in Agriculture Carcinoma of the Anterior 'Two-Thirds of the Tongue Carcinoma of the Skin Overlying Cartilage 62 Comparison of Rod Worth by Period and Analog Computer Methods Elimination of Control Rod Vibration Caused by Water Flow Effects of L-Triiodothyronine in Altering 'the Response of Kidneys to Cobalt-60 Irradiation Photochemistry of Thymine Solutions Distribution of Radioactive Antimony Formed by Nuclear Transformation in Antimony Oxides 1st Inter-American Conference of Chemical Engineers - October, 1961 San Juan, Puerto Rico In response to Joint invitation of ABC and the Governor of Nebraska - Oct., 1961 Lincoln, Nebraska Annual Meeting of the P.R. Medical Association November, 1961 San Juan, Puerto Rico Annual Meeting of the Radiological Society of W.A. - November, 1961 Chicago, Illinois Conference on Light Water Moderated Research Reactors - June, 1962 Oak Ridge, Tennessee Conference on Light Water Moderated Research Reactors June, 1962 Oak Ridge, Tennessee 4th Annual Meeting of the Radiological Society of N.A. - November, 1962 Chicago, Illinois Colloquium on Photochemical Transformation of Natural Products, 2nd Int. Symposium - Sept., 1962 Prague, Czechoslovakia Eastern Regional Meeting American Chemical Society November, 1962 Gatlinburg, Tennessee ---Page Break--- Author Title Dr. Henry J. Gonberg Utilization of Nuclear Energy for Civilian Purposes Case Report of Patient with Carcinoma of Thyroid Treated with I-131. The Use of Renogram in the Clinical Evaluation of Carcinoma of the Cervix Uteri Polygenic Variability Induced by Thermal Neutron Irradiation Effects of Ionizing Radiation on Permeation

Accumulation of Radio-nuclides in Marine Plankton and their Passage through Food Chains Prognostic Factors in Cancer of the Esophagus Cancer Mortality in Puerto Rico Aspects of Ascorbic Acid Metabolism in Acerola Ascorbic Acid Synthesis 10th Convention of the PAU of Engineering Societies, Aug. 1962 San Juan, Puerto Rico 59th Meeting of the PLR Medical Association November, 1962 San Juan, Puerto Rico 4th Inter-American Symposium on the Peaceful Application of Nuclear Energy, April, 1962 Mexico City, Mexico Annual Meeting of the Radiation Research Society May, 1962 Colorado Springs, Colorado American Society of Agricultural Sciences October, 1962 Mayaguez, Puerto Rico 3rd International Symposium on Water Pollution, Aug. 1962 Cincinnati, Ohio Annual Meeting of the Radiological Society of PR and the American College of Radiology Feb. 1962 San Juan, Puerto Rico 59th Annual Meeting P.R. Medical Association, Nov. 1962 San Juan, Puerto Rico American Society of Agricultural Sciences October, 1962 Mayaguez, Puerto Rico 59th Annual Meeting Puerto Rico Medical Association, Nov. 1962 San Juan, Puerto Rico ---Page Break--- Author Dr. Vicente J. Medina, Dr. Eddie Ortiz Dr. Edwin Roig Dr. Harry Semant Dr. William Stucki Title The Influence of Copper, Iron, and Form of Nitrogen on M099 Uptake in *Cajanus indicas* Inelastic Scattering of Iron Using a Neutron Source The Thallous-Thallium Exchange at Various Acidities in Perchlorate Media Scientific

Documentation in the Field of Chemistry The Structure of Beta-Hydroxysulfides Obtained by the Oxidative Addition of Thiols to Olefins The Synthesis of Intramolecularly Coordinated Boron Compounds Scientific and Technological Resources of Latin America The Scientific and Technological Resources of L.A. and the Alliance for Progress An Investigation of the Carotenoid Pigments of Achiote Place Presented American Society of Agricultural Sciences October, 1962 Mayaguez, Puerto Rico Meeting of the American Physical Society Summary, 1962 New York 8th Latin American Congress of

Chemistry September, 1962 Buenos Aires, Argentina Seminar on Scientific Documentation in L.A. sponsored by UNESCO September, 1962 Lima, Peru Latin American Congress of Chemistry September, 1962 Buenos Aires, Argentina 8th Latin American Congress of Chemistry September, 1962 Buenos Aires, Argentina Seminar on Chemical Industry of L.A. and the Common Market, 8th LoA- Congress of Chemistry September, 1962 Buenos Aires, Argentina The Johns Hopkins University- April, 1962 Baltimore, Maryland American Society of Agricultural Sciences October, 1962 Mayaguez, Puerto Rico ---Page Break--- Author Dr. Howard J. Teas Dr. José M. Tomé Dr. Jeanne Ubiñas Dr. John Villella Dr. J.A. Wethington Ismael Almodévar Title Keto Acid in 5 Tropical Plants Inhibition of Banana Fruit Ripening by Gamma Radiation Hodgkin's Disease: Our Experience at the Dr. I. González Martínez Oncologic Hospital Carcinoma of the Tonsil. Immune Responses to Irradiated Cercariae of Schistosoma Mansoni. Dosimetry from Photon Spectra and Pulse-Height Distributions 1963 A Neutron Diffraction Refinement of the Ca WO₄ Structure Method for the Isolation of Thorium from Siliceous Materials New Results in the Search for Alpha Particles from the Thermal Neutron Induced U-235 (n, γ) Th-235 Reaction B Place Presented Annual Meeting of the Society for Economic Botany- June, 1962 Washington, D.C. 2nd International Congress of Radiation Research- Aug., 1962 Harrogate, England 59th Annual Meeting Puerto Rico Medical Association- Nov., 1962 San Juan, Puerto Rico Annual Meeting of the Radiological Society of P.R. and the American College of Radiology February, 1962 San Juan, Puerto Rico American Society of Parasitologists and the Helminthological Society- June, 1962 Washington, D.C. 2nd International Congress of Radiation Research- Aug., 1962 Harrogate, England International Union of Crystallography- September, 1963, Rome, Italy 2nd Caribbean Chemical Symposium- August, 1963 (o Piedras and Mayaguez, Puerto Rico Physics Department of the University of

Bonn September, 1963 Bonn, Germany ---Page Break--- TM Author Dr. Tenaél AlnodSvar Rev. Ignacio Cantrell Dr. Helmut Bielen Dr. Helmut Bielen Dr. John C. Bugher Rev. Ignacio Cantarell Dr. Julio A. Gonzalo Rev. Ignacio Cantarell Dr. Malcolm Daniels Dr. Alec Grimison Dr. B. Chalmers Frazer Dr. Sergio Irizarry Dr. Mortimer Kay Title Search for Alpha Particles from Thermal Neutron Induced Ue39 (n, 'm23) Reaction Determination of Dissociation Vapour Pressure and Structure of Some Heavy Metal Sulfides Maclear Centers in Latin America: their part in Scientific Development. Transient Radiation Effects on Electron Emission of High- Resistivity Layers Time-Dependent Schottky Emission in Photomultiplier Tubes Photochemistry of Thiamine Magnetic Ordering in Some Related Orthorhombic Gacn and Poma Structures Fat Absorption Study with I-131 Labelled Oleic Acid in Patients with Cancer of the Uterine Cervix Receiving Cobalt Radiation to the Abdomen Neutron Diffraction Studies at the Puerto Rico Nuclear Center Place Presented 2nd Caribbean Chemical Symposium - August, 1963 Río Piedras and Mayaguez, Puerto Rico 2nd Caribbean Chemical Symposium - August, 1963 Río Piedras and Mayaguez, Puerto Rico Study Group Meeting on Research Reactor Utilization American Nuclear Soc. November, 1963 New York American Nuclear Soc. November, 1963 New York 2nd Caribbean Chemical Symposium August, 1963 Río Piedras and Mayaguez, Puerto Rico Symposium on Ferro-Magnetism and Ferro-electricity, June, 1963 Leningrad, Russia Thirty Second Annual Meeting of the P.R. Dietetic

Association June, 1963 San Juan, Puerto Rico International Colloquium of Neutron Diffusion and Diffraction September, 1963 Grenoble, France ---Page Break--- Author Title Dr. Francis KS, Actions of 5-Bromouracil Deoxyriboside on Plant Chromosomes Dr. Duane B. Linden Effects of Radiation on Paramutation Radiation Induced Modification of Paramutation Expression Dr. Duane B. Linden Uses of the PRNC Gamma Mr. José Cuevas Irradiation Facility in Mr. Vicente Rodríguez Agricultural

Research by Dr. Frank Lovman on Activation Analysis Method for Scandium, Antimony, and Phosphorus. Dr. Robert A. Luse on Resonance Radiation Effects of Low-Energy Monochromatic X-rays on Catalase. Dr. Henry J. Gomberg on Resonance Radiation Effects of Low-Energy Monochromatic X-rays on the metalloenzyme Catalase. Dr. Robert A. Luse on Basic Mechanisms in the Radiation Chemistry of Proteins and Nucleic Acids in Aqueous Media.

International Congress of Genetics, September 1963, Scheveningen, The Netherlands. 11th Annual Meeting of the Radiation Research Society, May 1963, Milwaukee, Wisconsin. 12th International Congress of Genetics, September 1963, Scheveningen, The Netherlands. Fall Meeting of the American Society of Agricultural Sciences, October 1963, Mayaguez, Puerto Rico. 2nd Caribbean Chemical Symposium, August 1963, Río Piedras and Mayaguez, Puerto Rico.

11th Annual Meeting of the Radiation Research Society, May 1963, Milwaukee, Wisconsin. 2nd Caribbean Chemical Symposium, August 1963, Río Piedras and Mayaguez, Puerto Rico. Conference on Basic Mechanisms in the Radiation Chemistry of Aqueous Media, May 1963, Gatlinburg, Tennessee.

---Page Break---

Dr. Victor Marcial on Cancer of the Penis. Dr. Victor Marcial on Radiotherapy in Carcinoma. Dr. Joo & Toné on Cervical Cancer. Dr. Fausto J. Muñoz on the Effect of Copper Sulfate on the Ceric Dosimetry System. Miss Milagros Miré on High Energy Gamma Photons. Dr. Juan Facetti on Neutron Conversion Device for Half-Life Measurements. Dr. H. Harry Samant on Base-catalyzed Formation of Indates. Mr. E.P. Olavarria on Association Constants. Dr. H. Harry Samant on Sulfoxide-Phenol Complexes. Dr. David Walker on Longevity of Adult *Diatraea saccharalis* (Fab.), Crambinae, Pyralidae, Lepidoptera. Dr. David Walker on Mating Behavior and Fecundity of *Diatraea saccharalis*, Mating Behavior of the Sugar-Cane Borer, *Diatraea saccharalis* (Fab.), Crambinae, Pyralidae, Lepidoptera.

Place Presented: 11th Congress of the Pan Pacific.

Surgical Association November, 1963, Honolulu, Hawaii Annual Meeting of the Western Branch of the P.R. Medical Association April, 1963 Mayaguez, Puerto Rico 2nd Caribbean Chemical Symposium August, 1963 Río Piedras and Mayaguez, Puerto Rico American Physical Society, January, 1963 New York and Caribbean Chemical Symposium - August, 1963 Río Piedras and Mayaguez, Puerto Rico 2nd Caribbean Chemical Symposium - August, 1963, Piedras and Mayaguez, Puerto Rico Fall Meeting of the American Society of Agricultural Sciences Oct., 1963 Mayaguez, Puerto Rico Entomological Society of America Meeting December, 1963 St. Louis, Missouri Fall Meeting of the American Society of Agricultural Sciences - Oct., 1963 Mayaguez, Puerto Rico ---Page Break--- 1 Author Title Place Presented Dr. David Walker Oviposition by *Diatraea saccharalis* (Fab.) American Society of Agricultural Sciences Lepidoptera October, 1963

Mayaguez, Puerto Rico Dr. M.P. Weinbren Rift Valley Fever and 11th International Congress of Tropical Medicine and Malaria September, 1963 Rio de Janeiro, Brazil Dr. Owen H. Wheeler Acid-catalyzed Solvolysis of Some Substituted Butyrolactones and Valerolactones 2nd Caribbean Chemical Symposium August, 1963 Rio Piedras and Mayaguez, Puerto Rico Dr. Owen H. Wheeler Oxidation of Primary Aromatic Amines with Manganese Dioxide 2nd Caribbean Chemical Symposium - August, 1963 Rio Piedras and Mayaguez, Puerto Rico ---Page Break--- STUDENTS TRAINED AT PRNC ACADEMIC YEARS ---Page Break--- Student Statistics FY 1958 - FY 1964 "58 "59 "60 "61 "62 "63 '64 TOTAL Argentina Bolivia Chile Colombia Costa Rica Cuba Ecuador El Salvador Great Britain Guatemala Haiti India Japan Mexico Nicaragua Panama Paraguay Peru Philippine Islands Santo Domingo South Africa Spain Uruguay Venezuela Total Non-U.S. Citizens 9 2 2 4 2 3 35 169 U.S. Citizens 50 52 74 74 11 161 176

687 TOTAL STUDENTS 59 72 98 95 122 97 al 8% Seen a 9 ---Page Break--- 80 uses [coves cvs | s'seZt eeoary | sous | Coteus we ee =m HHT wT ar TERT o ste : veto | o's ast wate | actus 0 wutye ~ | out] worn | ance cate | sites | canoe me was] - | was | crs | mss stun s | uctas | act t wt Tr RT |S Tay |e FE T= waa aya] coters cy extees | ecto sacs actors | antette we wae THE waa RET we | wa ay sartoot | 2300 rte | tes | otats | totes m4 ster | onc atts | soto cars | untcs} - | uvtus ow assis} su oxtaas | wstens] wee §] omtorg | - - - wt ecell|icoeee Tar eT | Tee, | aa | Seo] — Toe I ST worqeonpg paw SupuTeAy - Lo wesTorg ROOT-OSET AE SmAALTONREEKE oma ---Page Break--- a ars | om'ae | antons | ontects | stone | stats 5 a i wet WE OTE wt we aa wee = ~ ~ ay cetis - cotes | wots | asters | scoters ° ° S a, saute = sate oS = ° e ° ° on wes] > wes a 2 S - : : wt a a wT T= me seoustos TwoTshug - so wesBoxa sstans | ontes ausccs | custecrs | uveters | srsteog | onttast | cots eet HT OE wT AEST eT Cae | OTE ews a esott : sects | zante 16 : - - 0 uastest © ste, oy : - : we setauts a wetas | uctos | oes a : : wt Ter | veer | suarezeay_|— Tey | —yuaetrdy_| —sroyyened | — Tero] | —yunaahoy | —saraeaety aa l= ayy l= auroTpen pus AoTOSE = gp wesForg ---Page Break--- EMPLOYMENT STATISTICS Program 07 - Training & Education Program 05 - Biology & Medicine Program 05 - Physical Sciences FY-1958 FY-1955 FY-1960 FY-1961 Category Program 07 | Program 07 | Program 07 | Program 07 Scientific 6 25 Technical 23 31 3 Other 7 6 35 28 Administrative 5 8 10 30 Total 43 63 87 120 FY-1962 FY-1963 FY-1964 Program Programs | Program Programs | Program Programs Category OT 05 & OT 05 & 6 OT 5 & Scientific 48 1 330k MB Technical, n 3 na 62k Other 53 1 31 8 ee) Administrative 42 ° a ° ho ° Total 213 5 176 50 201 3 ---Page Break---