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MONTHLY STATUS AND PROGRESS REPORTS

FOR

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III - BIOLOGY AND MEDICINE

Research Projects Approved or Renewed During September, 1950

The following numbers of research projects were approved for negotiation or renewal during September for direct AEC administration:

	No. of projects	Amount
Biology	3	$20,300
Medicine	5	76,048
	8	$96,348

Advisory Committee for Biology and Medicine

The Advisory Committee for Biology and Medicine held its twenty-third meeting at the AEC in Washington, D. C., on September 8 and 9, 1950. On Friday, September 8, a visit was made to the AEC Project at the U. S. Department of Agriculture in Beltsville, Maryland, for the purpose of viewing methods and uses for radioisotopes in problems relating to soil and fertilizers.

In connection with the review of the budget, a full discussion was held of the over-all research program for the Division of Biology and Medicine. It was the sense of the Committee that there be no curtailment of the research program and that within our program universal emphasis be placed on the acquisition of fundamental knowledge.

Dr. George A. Hardie, of the Medical Branch, and Mr. John V. Lannon, of the Division of Finance, reported on their visit to the Atomic Bomb Casualty Commission in Japan. Dr. Hardie's report has been made available to the Commission and to the Division of Medical Sciences of the National Research Council. Copies are on file in the Division of Biology and Medicine.

The Committee studied the problems emanating from the discussions and made specific recommendations as to the research program which have been forwarded to the Chairman of the AEC.

Biology

Radiation damage in plants. The Phytoradiology group at Argonne National Laboratory was initiated as a project to study the effects of radiation on higher plants. One of the major controlling factors of plant growth and development is the growth hormones. Plant growth hormones are commonly known as auxins, on the basis of their regulatory function of growth. They possess other important properties, but their function on growth, that is, irreversible increase in size or volume, is definitive. Acting in minute concentrations (physiological amount being sometimes as little as a millionth of a millionth of a gram), they provide a sensitive mechanism of correlative regulation. Auxins exist in a free, readily extractable state in all living cells of the plant. The chief site of auxin synthesis is the growing terminal bud of the higher plant.

The response of the plant to directly or indirectly caused variations in hormone level has been intensively studied in the past two decades. Since a number of the observed effects of high energy radiations are similar in effect to those caused by changes in auxin level, the effect of such radiation on auxin and auxin economy becomes pertinent to research upon the mechanisms of radiation effects.

The auxin native to the plant is chiefly, if not wholly, the heterocyclic compound indoleacetic acid. Investigators at Argonne National Laboratory have been studying the effect of ionizing radiation (1) on auxin in in vitro and in vivo systems, (2) on the biosynthesis of auxin in the living plant tissues, and (3) on physiological processes controlled by auxin.

X-radiation inactivates auxin in aqueous solutions with apparent first order kinetics. Accompanying organic compounds are able to protect auxin against inactivation by ionizing radiation. Such protective action was shown by ethanol, glucose, ascorbate, cysteine, glutathione, and citrate--all natural components of a plant. What, then, is the effect of ionizing radiation on auxin in the living plant? Here we must distinguish between auxin and auxin formation, or biosynthesis.

Using kidney bean, cocklebur, and cabbage plants, free auxin levels were determined immediately after various single doses of X-radiation. Radiation doses as low as 25 to 100 roentgens cause an immediate drop in free auxin levels. As the radiation dose is increased, the absolute amounts of free auxins in the tissue progressively decrease.

Depending on the plant material, it takes from 50 to 1,000 ionizations produced in the tissues to inactivate one molecule of auxin when X-radiation is initiated. This is in contrast to the initial inactivation efficiency of one molecule per ionization when a pure aqueous solution of the hormone is irradiated. We have seen that indoleacetic acid is readily protected in vitro by other oxidizable organic molecules. When we consider the tremendous excess of molecules in the cell which could compete with indoleacetic acid for the radiation-induced oxidizing groups, the efficiency of free auxin inactivation is surprisingly high.

Continued production of auxin is likewise inhibited by low radiation doses from 25 to 10,000 roentgens, their auxin levels being followed by periodic sampling after irradiation. Auxin formation is inhibited in the kidney bean by as little as 25 roentgens, with progressively stronger inhibition by higher doses. Recovery to control levels of synthesis after irradiation is attained in from several days to 2 weeks, depending on the dose. Doses of 10,000 roentgens result in increasingly depressed biosynthesis, with no recovery.

The effectiveness of low doses of ionizing radiation can be interpreted as due to its action upon molecules which affect multi-molecular turn-over, that is, the enzymes. If the enzyme system involved in auxin supply is radiosensitive, the free auxin reservoir would be rapidly lowered, as manifested by reduced auxin level in extracts after irradiation.

Biochemical investigations are under way dealing with the effect of ionizing radiation directly on the system involved in growth hormone synthesis. Exposure of the plant to radiation doses caused decreased growth and decreased auxin concentration. The effect of the low radiation doses can be reversed by applying synthetic growth hormone to the plant following irradiation. The effect of higher radiation doses cannot be reversed, implying that a more profound biochemical injury has taken place such as on the enzymes.

Morphological changes due to irradiation can likewise be shown to be due, in part, to radiation sensitivity of the hormone system. Plant workers are familiar with the phenomenon of apical dominance. The terminal growing point, or bud, suppresses the growth of lateral buds. When the terminal meristem is cut off, or severely injured, the lateral buds immediately leave their "dormant" state and begin growing. This process was shown a number of years ago to be specifically controlled by the auxin produced by the terminal bud. Thus, when the stem tip is removed and auxin alone is applied to the stump, the laterals stay suppressed as long as the auxin source is allowed to remain. If the applied source is in turn removed, normal growth of the laterals is immediately initiated.

Terminal growing points of the cocklebur were irradiated with single low doses of X-irradiation, the remainder of the plant being shielded with lead. Lateral bud growth ensued, the buds increasing over 100 percent in size within 2 days. When auxin was applied to the tips immediately after irradiation, lateral buds stayed suppressed. We can therefore conclude that these apical dominance responses to irradiation are chiefly, if not wholly, due to radiation sensitivity of the auxin supply system.

When growth hormone is present in tissues, it is relatively insensitive to ionizing radiation. Auxin itself in plant tissue does not appear to be unduly radiosensitive. However, the process of auxin formation is relatively sensitive to radiation, and provides an explanation, in part, for changes in growth and development of higher plants exposed to relatively intense, low doses of ionizing radiation.

Medicine

Red Cross research contract (Harvard) on separation of white blood cells and platelets. Within the past month investigators working on the above AEC-supported contract have devised means of separating white blood cells from other blood constituents. The separated white cells remain viable for approximately 2 weeks, whereas white cells handled by ordinary methods are destroyed almost immediately. This development marks a real milestone of progress since the separated white cells can now be transfused separately, and their possible usefulness in combatting the overwhelming infection which accompanies acute radiation injury, leukemia, and certain disease conditions can be determined on a sound experimental basis. Arrangements have been made for several AEC laboratories and investigators to obtain supplies of white blood cells.

Progress has also been made toward the separation of viable blood platelets. Platelets are necessary to control the hemorrhagic stages of acute radiation injury, leukemia, and other disease conditions.

Biophysics

Interim approval has been granted to plans for the return of radioactive wastes by off-site users in the Berkeley Area to the Radiation Laboratory, for disposal at sea. It is specified that the wastes must be encased in concrete in steel drums, according to definite specifications, and shipped to the Radiation Laboratory for this service. A somewhat similar plan permits the return of wastes, properly packed, to ORNL for burial there. It is expected that operation of these two plans will furnish needed experience and cost data on which to base a sound over-all waste disposal policy.

Representatives from AEC emergency monitoring teams were informed of the amounts of penetrating radiation to which team members may be subjected in an emergency. As a framework for the officially permissible emergency dose values, it was pointed out that a true emergency dose will necessarily be a function of the degree of the emergency, but that doses of 50-100 roentgens will subject the recipient to possible injury, that it would very likely shorten his life span, and especially that it greatly depletes his "reserve" which enables him to withstand radiation which he would receive from nature, from atomic energy operations, and from X-rays in diagnosis or therapy. On the basis of these considerations, the officially permissible emergency dose has been set at 10 roentgens for members of AEC teams, whose members would normally receive some exposure in the course of their daily work, and 25 roentgens for members of Civil Defense monitoring teams.

Discussions have been held with interested staff members regarding the health physics organization to be set up at the new site. It is expected that the contractor will administer the technical phases of the organization in contrast to the Arco plan which will operate site and personnel monitoring through central AEC facilities. One problem is the training of personnel which must be carried out in one of the present AEC installations.

A conference was held at the University of Rochester for the purpose of crystallizing a program of research on plutonium and radon inhalation, as a complement to the work on injected radioactive substances which has been set up at the University of Utah. The Rochester program will get under way as soon as quarters can be provided through laboratory remodeling and construction, plans for which have been approved.

Civil Defense Liaison Branch

NSRB Civil Defense Exercises. A representative of the Branch was present at the Chicago Civil Defense Exercise during the week of September 25 as a member of the NSRB Interdepartmental Working Group on Interim Civil Defense Plans for Key Areas. This project was the last of three exercises conducted jointly by the NSRB and selected metropolitan areas. The Chicago exercise was attended by four state governors, some 20 state civil defense directors or their representatives, and representatives of approximately 150 local civil defense organizations. Foreign visitors were present from Great Britain and Canada.

Emergency Radiation Monitoring Program. A meeting was held in Washington on September 22 of representatives of the five Operations Offices responsible for operation of this program in their respective areas. Agreements were reached as to allocation of territory for each area, policy for contacts with local governmental agencies, standardization of radio communications equipment, permissible limits for food and water contamination, emergency personnel permissible doses, loan of instruments to state or city organizations for training purposes, and several questions of administration of the program such as budgeting, procurement, contract arrangements, identification cards for team members, etc.

The Civil Defense Office of NSRB is to be asked to inform the states of the establishment of the monitoring teams, clearly stating the limitations and responsibilities of the teams.

Radiological Monitor Instructor Training Program. During the month a proposed certification for recognition of successful completion of the various radiological monitoring courses given by the AEC in collaboration with the NSRB was worked out with the cooperation of the Division of Organization and Personnel and submitted to NSRB for concurrence.

Distribution of information. Copies of the NSRB publication "United States Civil Defense" were furnished each Operations Office and, through the area coordinators, to the emergency radiation monitoring teams.

Each center which gave the radiological monitor training course was provided with copies of the "Effects of Atomic Weapons" for forwarding to their students.

Radiation Instruments Branch

A conference on The Chemistry and Physics of Radiation Dosimetry, sponsored jointly by the Department of Defense and the Atomic Energy Commission, was held on September 18, 19, and 20, 1950, at the Army Chemical Center, Edgewood, Maryland. The problems concerning liquid, crystal, self-developing photometric, and other types of dosimeters were discussed. The current Department of Defense program in dosimetry was discussed in a closed session on the third day.

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