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UCRL-115 1948

REPORT PROPERLY DECLASSIFIED

J H Green 3-25-80

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Larry Bakken

UNIVERSITY OF CALIFORNIA
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MONTHLY PROGRESS REPORT NO. 61 FOR MAY, 1948

Berkeley, Californi-

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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

MONTHLY PROGRESS REPORT NO. 61 FOR MAY, 1948

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1. 184-inch Cyclotron Program

The cyclotron was used for research experiments ninety-two percent of the 481 hours that the crew was on duty. One third of this time was spent on the investigation and possible elimination of the scattered particles found in the photographic plates used for meson detection.

The dee stem and rotary condenser vacuum chamber for the proton conversion unit was evacuated during the month and was found to be tight. The cooled liners, insulators, etc. are being installed on this tank at the present time.

2. 60-inch Cyclotron Program

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The 60-inch cyclotron operated at a fairly high efficiency during the month of May and there were no major shutdowns. Work was continued on the ion sources research. With the aid of Professor Seaborg's group, work on the identification of C^{12} particles and the new anthracene counter was resumed.

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3. Synchrotron Program

Continued adjustment of the phase variation in the magnetic field around the orbit has resulted in reducing the amplitude of all of the harmonics to what is believed to be a tolerable value. It is probable that additional adjustment will be necessary in order to obtain maximum output. This adjustment, however, will be made by use of beam intensity measurements rather than direct observation of the magnetic field.

The magnet excitation equipment has been re-designed and the new features installed in bread-board form. The operation of the magnet with these new circuits appears to be satisfactory and the manufacturing company is supplying permanent equipment to replace the bread-board installation.

The radio frequency system at present does not perform satisfactorily when a magnetic field is present. It is believed that this trouble is due to electron oscillations producing ionization which overloads the oscillator. Various methods of suppressing this ionization are being investigated. Considerable trouble has been encountered with breaking of some of the dee hairpins. Re-design of the inner dee structure has been completed, and new dees are on order in the shop. Concurrently with installation of the new dees, some revisions in the quarter wave transmission lines will be made to suppress the above mentioned ionization.

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Several unsuccessful attempts have been made to observe a 2 Mev betatron beam. The exact difficulty is still unknown and probe measurements are now in progress to determine the portion of the orbit in which the beam is being lost. The electron current which reaches a probe 90° from the injector is entirely adequate. It is suspected, therefore, that most of the beam is being lost in the dee section - possibly due to intermittent shorting of some of the dee hairpins.

Some revisions are being made in the electronic monitoring equipment since at various times during the attempted operation the timing of specific events has been questioned, and the monitoring equipment has not permitted good observation of this timing. Some improvements are also planned to eliminate cross-talk in circuits which carry low travel signals. In at least one instance, the beam current to the probe is known to have been lost in one of the trunk lines from the magnet room to the control room.

4. Linear Accelerator Program

Van de Graaff Generator. Some imporvement of operation with a d.c. beam was noted following the installation of the focusing grid. However, further experience will have to be acquired before it is clear as to whether or not further changes will have to be made. Tests of an activated charcoal trap as a means for reducing the amount of oil vapor in the differential pumping system look very promising. A pressure of about 2×10^{-7} mm. Hg. is being held on the test system. This is lower by a factor of at least 50 than can be obtained without the trap. Plans are under way for installation of such a trap in the machine. During May a 4 Mev beam of protons was available for a total of 113 hours, as contrasted with 55 hours for April.

Linear Accelerator. About 80 percent of the time, during which the beam was available, was spent on preliminary runs of the proton-proton scattering apparatus. Scattering has been observed in both the photographic apparatus and the proportional counter equipment. Approximately 15 percent of the time was spent on short half life bombardments, mainly refinement of the data on the Al^{25} and Al^{26} half lives. Five percent of the time was spent on inelastic scattering.

A small leak appeared in the drift tube water line, and the tank was opened up, for the first time in three months, in order to fix the leak. The silver plating was found to be in excellent condition. The transmission line seals were also in very good shape, and all grids were in perfect condition. The only surprising discovery was that many drift tubes had become misaligned axially, some as much as 1/4". It is remarkable that the machine had been operating perfectly with this bad misalignment. The only detectable radioactivity on any surface inside the accelerator was approximately 0.2 of an m.r. per hour in the first drift tube. When the accelerator was closed after fixing the leak, it was found that the X-ray radiation was down by approximately a factor of two, probably due to the equalizing of fields between the drift tubes. Some additional shielding was added to the high energy end of the linear accelerator in order to reduce the probability of gamma ray pile-up which would produce spurious counts in the proportional counter proton-proton scattering apparatus.

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5. Experimental Physics

Cloud Chamber. During the month the experiments on n-p scattering have been completed and the results are in process of preparation for publication.

A determination is being made of the energy spectrum of the delayed neutrons emitted from the decay of N^{17} by measuring the range of the proton recoils in a hydrogen filled chamber.

Film Program. Considerable attention has been given to the problem of reducing the background on photographic plates exposed for the study of mesons. This "background" consists of proton tracks from neutron-proton collisions and proton and alpha-particle tracks from neutron-initiated stars. The ratio of background tracks to meson tracks has been about 10 for the best plates obtained so far, and has been as high as 10,000 for the bad plates. Although there has been some improvement in the reproducibility of exposures, the factors affecting the background are still not completely understood.

A contribution to the reproducibility of exposures has been made. A double probe has been built which will read alpha-particle current and deuteron current separately. This enables the cyclotron operator to set the arc pulse at the correct place in the frequency modulation cycle to get the maximum ratio of alpha-particle current to deuteron current. Ratios of the order of 50 are commonly obtained. Previously there was no positive method of finding the ratio of the numbers of alpha-particles to deuterons in the beam, and a great deal of the background troubles may have come from large deuteron contamination in the beam.

Positive Mesons. The run of May 29 produced several good plates exposed to positive mesons. One example has been found of a positive meson decay in which the track of the secondary meson ends in the emulsion. The range of the secondary meson is 630 microns, in agreement with the observations of Lattes, Occhialini, and Powell.

Total Cross Sections for High Energy Neutrons. The bismuth fission chambers used as monitor and detector in these measurements display satisfactory plateaus, and have given consistent and reproduceable data on elements studied thus far: namely, lead, copper, carbon and beryllium. Values for total cross sections lie generally about 10 percent lower than those measured using $C^{12}(n, 2n)C^{11}$ reaction for detection.

Neutron Diffraction Measurements. Measurements of elastic scattering cross sections for high energy neutrons using proportional counter detection of recoil protons continue to give values agreeing with measurements made with carbon detectors. The problem of monitoring the neutron beam over the very large intensity range seems fairly well in hand, through the use of BF^3 counters in the shielding wall adjacent to the beam hole.

Delayed Neutrons. Further research on delayed emission of neutrons awaits completion of instrumentation.

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6. Theoretical Physics

Problems worked on included n-p scattering at 45 Mev in addition to more accurate 90 Mev calculations; better estimates of star sizes to be expected in photographic plates bombarded by deuterons; yields of spallation reactions; range straggling of high energy deuterons; cross sections for production of mesons by cyclotron and synchrotron; and the angle and energy spectra of the mesons. A considerable amount of work was also done on bevatron problems.

7. Isotope Separation Program

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JA Calutron. During the past three months the conversion of the JA equipment was begun preparatory to research on isotope separation by a new method suggested by E. O. Lawrence. This method makes use of a 360° calutron beam trajectory with an rf modulation on the beam intensity. A corresponding potential modulation is applied to the collector with such a phase as to reject unwanted isotopes and to admit the mass desired.

The first 360° unit was completed, and three radio frequency oscillators constructed. This unit was designed for an argon beam, approximately 6" in radius. The collector was placed within 3" of the end of the 360° circular path. The system has a grounded C and the beam intensity is modulated by a variable potential applied to the G.

It was determined by applying a variable d.c. voltage on the G that the beam could be intensity modulated to 95 percent, by placing the G at the same potential as the M. With M voltages up to 8 kv, and 60 cycle voltages on the G up to 7.5 kv peak, the beam could be modulated to nearly 100 percent for nearly 1/2 cycle as observed on an oscilloscope. Radiofrequency voltages (100 KC, 700 KC and 1.5 MC) were then applied to the G. Because of the restricted voltage output of the oscillator (7 kv peak) it was necessary to limit the M voltage to 4 or 5 kv. The beam could be modulated to about 25 percent. It was observed that the low frequency hash, normally on the beam for d.c. G voltages, was greatly attentuated when radio frequency voltages were applied to the G. Such low frequency hash of up to 1,000 cycles per second frequency was typically attentuated by a factor of approximately 10. At this point in the investigation, it was decided to rebuild the unit, also to construct a new radio frequency oscillator, providing a much larger output voltage. The unit is now revised and will allow a radio frequency voltage to be applied to the first collector. A second collector plate is mounted so as to intercept any part of the beam reflected from the first collector after it has traversed an approximately quarter circular path. The beam is, of course, rejected at the first collector when its instanteous voltage is positive with respect to the J slit.

Tests will be started immediately using roughly the follwing conditions: Magnetic field 6 kilograms, beam radius 6", M voltage 10 kv, rf G voltage 15 kv peak at 1.5 MC. Shims have been placed in the JA tank to make the magnetic field uniform within 1/2 percent throughout the region traversed by the beam. A change of magnetic field of 1/2 percent corresponds to a phase shift of about 15° in the beam arriving at the collector.

Nier Spectrometer. This instrument with a recording electrometer circuit has been in regular operation during this month on a classified problem.

8. Chemistry

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Part A

Radioactive Properties of the Heavy Isotopes. In a previous monthly summary it was mentioned that some new alpha decay series, collateral to the natural radioactive series, could be produced by irradiating thorium with high energy deuterons. The energies and half-lives of the alpha-particles were characterized, but the mass number assignments were still somewhat in doubt. In particular, the series beginning with

a protactinium isotope of 38-minutes half-life thought to be Pa^{226}, is now definitely established as a collateral chain to the actinium series in which the protactinium isotope is Pa^{227}. The available information on this series may be summarized as follows:

$$\begin{array}{ccccccccc}
Pa^{227} & \xrightarrow[38\text{-min.}]{\alpha(6.46)} & Ac^{223} & \xrightarrow[\sim 2.5\text{-min.}]{\alpha(6.64)} & Fr^{219} & \xrightarrow{\alpha(7.30)} & At^{215} & \xrightarrow{\alpha(8.00)} & \\
\downarrow K & & & & & & & & \\
RdAc(Th^{227}) & & AcC(Bi^{211}) & \xrightarrow[2.16\text{-min.}]{\alpha} & AcC''(Tl^{207}) & \xrightarrow[4.76\text{-min.}]{\beta^-} & Pb^{207} & &
\end{array}$$

The orbital electron-capturing branching for Pa^{227} was determined through the growth of Rd Ac^{227}. The various members of the alpha decay series were identified by catching successive alpha-recoils. For example, the recoils from Pa^{227} contained Ac^{223} and all of its daughters; the recoils from this plate showed only the AcC alpha-peak since the francium and astatine isotopes are very short lived. The recoils obtained from the AcC plate showed only the 4.8-minute beta activity of AcC".

Another series, collateral to the thorium decay series was identifified starting with Pa^{228}. The energies, half-lives, and branching in the decay are shown as follows:

$$\begin{array}{ccccccccccc}
Pa^{228} & \xrightarrow[22\text{-hr.}]{6.09\ (\sim 1\%)} & Ac^{224} & \xrightarrow[2.5\text{-hr.}]{6.17\ \alpha(\sim 2\%)} & Fr^{220} & \xrightarrow[\text{short}]{6.69\ \alpha} & At^{216} & \xrightarrow[\sim 100\ \mu\text{sec}]{7.79\ \alpha} & ThC^{212} & \xrightarrow[10.6\text{-hr.}]{60\ \text{min.}} & \\
\downarrow K(\sim 99\%) & & \downarrow K\ (\sim 98\%) & & & & & & \beta^- \uparrow & & \\
RdTh^{228} & \xrightarrow[1.9\text{-yr.}]{\alpha} & ThX^{224} & \xrightarrow[3.64\text{-d.}]{\alpha} & Tn^{220} & \longrightarrow & ThA^{216} & \longrightarrow & ThB^{212} & & \\
\end{array}$$

It was recently reported by Gregoire and Perey (Compt. Rend. 225, 733 (1947)) that the rare alpha decay of Ac^{227} possesses fine structure. They report that 85% of the disintegrations take place through a 4.95-Mev alpha-particle and 15% through a 4.6-Mev alpha-particle. Since this seemed contrary to previous measurements made in this laboratory, a more careful examination of purified actinium was made using the alpha pulse-analyzer. There was no evidence for the short-range alpha-group, i.e. an upper limit of about 0.5% could be attributed to alpha-particles of about 4.7 Mev or less. On the other hand, with the same instrument setting, the short-range group of Pa^{231} stood out very clearly. The two protactinium groups bear almost the identical relationship to each other as that which was reported for actinium.

Nuclear Reactions with High Energy Particles. The yields in spallation reactions of antimony have been determined for 400-Mev helium ions and deuterons of 200, 100, 75, and 50 Mev. Particular attention was paid to twenty different isotopes in the region from silver to tellurium, inclusive. One of the characteristics noted was that the cross sections for the formation of the tellurium and antimony isotopes covering the mass number range of 118 to 124 did not change drastically over the wide range of projectile energies. There was also evidence that reactions involving the ejection of many protons are much more rare than those involving the removal of neutrons under conditions in which the energy available to the nucleus is sufficient for both processes. For example, with 400-Mev alpha-particles the yields for Cd^{107} and Cd^{109} are much greater than for Cd^{115}. With 200-Mev deuterons the same effect is still noticed although the difference has become

less pronounced. With 100-Mev deuterons, the yield for Cd^{115} is greater than for the lighter cadmium isotopes. A study has also been made of the independent yields of the Cd^{115} isomers. It was found that at all energies, the ground state (42-d. Cd^{115}) was formed in two- to threefold greater yield than the upper state (2.5 d. Cd^{115}). It is interesting to note that in the fission of thorium with 38-Mev helium ions and uranium with slow neutrons, the upper state is formed in tenfold greater yield than the ground state.

Mass Spectrograph Studies. A Nier-type mass spectrograph for determining mass assignments of radioactive isotopes has been placed in operation and the first results have been obtained on rubidium isotopes formed from the irradiation of bromine (NH_4Br) with 60-Mev helium ions. For the short-lived rubidium activities two lines were obtained at mass numbers 81 and 82 using the photographic plate transfer technique. The lines were of approximately equal intensity, and since the Geiger counter activity decreased through many half-lives with $\sim$6 hr. half-life, it is probable that both Rb^{81} and Rb^{82} possess half-lives close to this value. A 6.5-hr. half-life had been previously attributed to Rb^{84}.

Chemistry of the Transuranium Elements. The complex ions of americium and curium are being studied in conjunction with separation studies using a Dowex resin column. With citrate as the eluting agent, curium precedes americium off the column. In HCl solution it has been found that the order tends to reverse as the HCl concentration increases. With 11.6 M-HCl in 20% alcohol solution, the americium actually precedes the curium with a separation equivalent to that in the citrate solution in which the curium comes off the column first. An interesting possibility for the effect of chloride at high concentrations is that complex ions are being formed with 5f electrons, in which case those of americium would be more accessible and therefore form the stronger bonds.

Chemistry

Part B

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Synthetic and Experimental Chemistry. The studies of the synthesis of carbon-labeled anthranilic acid, hydroxyanthranilic acid, ring-labeled aromatic compounds, and stilbamidine have continued. Radioactive choline acetate labeled in the N-methyl group C^{14} has been prepared on a small scale. The yield based on methyl iodide is about 80 percent. Acetyl choline acetate has been prepared from this material by the direct action of acetyl chloride. The experiments on the relative strength of the C^{12}-C^{14} and the C^{12}-C^{12} bonds are continuing.

Biological Chemistry. In the study of the metabolism of C^{14}-labeled tyrosine and dihydroxyphenylalanine to melanin some effort has been expended in developing a degradation procedure whereby melanin can be extracted from tumor tissue which has been incubated with these radioactive compounds. The problem is to extract the pure melanin free from extraneous activity which is not due to the enzymatic synthesis of melanin. It has not been possible thus far to obtain completely inactive melanin when the enzymatic systems have been killed or blocked by the use of carbon monoxide or hydrogen sulfide.

The conversion of tryptophane to kynurenine, kynurenic acid, and nicotinic acid in mammals has been studied with the use of radioactive carbon. In these experiments Dl-tryptophane-β-C^{14} was administered to rabbits, dogs, and rats. The kynurenine and kynurenic acid isolated from the urines were radioactive, and by degradation the label was found to be in the methylene group and the 3-position of the two compounds, respectively. The N-methylnicotinamide was not radioactive, indicating that it was produced from tryptophane by some method other than a ring-closure to a quinoline

derivative followed by oxidation. From the data obtained, it was formulated that the kynurenine is formed from tryptophane by direct opening of the pyrrole ring, and the kynurenic acid by direct ring-closure from kynurenine.

Photosynthetic Chemistry. In the study of the dependence on dark $C^{14}O_2$ fixation on carbon dioxide partial pressure, the dependence of the amount of carbon dioxide fixed in the dark during one-minute by pre-illunimated Scenedesmus cultures on the concentration of the carbon dioxide has been determined. The resulting pressure dependence curve is almost identical with the curves for the carbon dioxide pressure dependence steady state photosynthetic rates. This is addition inference that the dark fixation of carbon dioxide by plants proceeds by the same mechanism as does photosynthesis, and thus the data obtained on the dark fixation of carbon dioxide are applicable to photosynthetic processes.

Work on the identification of radioactive amino acids photosynthesized by algae in short periods of illumination (30 seconds) has continued, and a number of radioactive amino acids have been identified. Besides aspartic acid and alanine, which occur in major amounts in Scenedesmus and Chlorella and which have been mentioned in previous reports, asparagine, serine, β-alanine, and phenylalanine have been identified by radio autographs of filter paper chromatograms. All the radioactive amino acids thus identified are three- and four-carbon acids (considering phenylalanine as a substituted alanine), and this substantiates earlier work of this laboratory which led to the postulation of a scheme for photosynthesis involving three-and four-carbon carboxylic acids. The complete absence of labeled glutamic acid in short periods of photosynthesis indicates that the tricarboxylic acid cycle (characteristic of the respiration process) is not involved in photosynthesis. In addition to the above mentioned radioactive amino acids, fifteen of the known amino acids have been found to occur in Chlorella extract, but the rest of these contain no substantial amount of radioactivity.

Work is continuing on the use of ion exchange resins for the separation of amino acid mixtures, and a working theory is being developed for the separation process. As the radioactive amino acids are isolated, they will be degraded and the relative amounts of the radioactivity in the various positions will be determined.

Experiments have been carried out to determine whether the presence of acetate inhibits or accelerates photosynthesis and respiration in Scenedesmus. Both starved and fresh cells were used, but no effect was found. In experiments with C^{14} carboxyl-labeled acetate, it was found that all the acetate which penetrated the cell membrane was fixed in some form other than acetate or acetyl phosphate.

Chemistry

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Part C. Sub-project 48B

Metals and High Temperature Thermodynamics. Work is in progress on the following problems:

1. Thermodynamics of CN and CH.
2. Thermodynamics of gaseous molybdenum and copper halides.
3. Absorption coefficients of species in sun.
4. Low melting metal alloys.
5. Refractory studies.
6. Construction of 4000° furnace.

Work has been completed on the following:

1. Heats of formation of Na-Sn and Li-Sn alloys.
2. Theory of the solid state. (Paper being written).
3. Report on thermodynamics of the oxides. (Submitted for typing).

Basic Chemistry. Solvent Extraction. The following problems are under investigation:

1. The aqueous chemistry of zirconium.
2. The formation of the urnayl-TTA chelate in aqueous solutions.
3. Complex ion formation of lanthanum.
4. Solvent extraction of uranyl salts.

A report is being issued on the aqueous chemistry of zirconium.

9. Medical Physics

Part A. Project 48A-I

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Radioautographic studies are continuing using Pr^{143}, Y91, and Sr^{89}. The radioautographic studies using Sr^{89} are being performed for the purpose of investigating the deposition of this radio-isotope in bone at very short intervals following injection. Continued effort is being directed toward improving the radioautographic techniques.

During the month of May, metabolism studies have been set up involving radio-cadmium in an effort to devise methods of eliminating this material more readily from the liver. Characteristic tracer studies are under way using Pr^{143}. Fifteen day and sixty-four day intramuscular radio-vanadium studies are in the process of completion. Fifteen days following intramuscular injection of vanadium, the major portion of this radio-element is found in the excreta; of that remaining in the animal, the largest percentages are found in liver, kidney, and muscle. The 1 and 4 day intramuscular studies of U^{230} have been completed. The deposition of this element in bone is lower than that reported for U^{233}. Further studies are planned using various uranium isotopes in order to verify this point. The 64 day intramuscular administration studies with actinium have been completed. The deposition of this element, 64 days following administration, is primarily to be found in the skeleton, liver, and muscle as well as to a large degree in fecal excretion. A comparative study between the metabolism of Ca^{45} and Sr^{89} has been completed and will be presented in detail in a formal report.

The value of massive doses of parathyroid hormone as a means of producing bone resorption was investigated. Young 150 gram rats were injected intraperitoneally with 1 unit/gm or 5 units / gm. of parathormone, and six hours later were given carrier-free radio-phosphorus or radio-strontium intraperitoneally. Eighteen hours later, they were sacrificed. The lower dose produced no significant changes in blood chemistry or in the distribution and excretion of phosphorus or strontium, although there were definite histological signs of bone resorption and osteoclast activity. The larger dose did cause a significant rise in blood calcium, a marked increase in urinary excretion of both phosphorus and strontium, and a reduction of the amounts of both these elements which were deposited in bone. There was also an increase in the soft tissue radio-phosphorus. The bone ash was reduced somewhat even after this short period. It is evident that massive doses of parathormone in the rat will produce active bone resorption, and the value of this treatment in conjunction with zirconium citrate is to be investigated. It is hoped that bone resorption may release plutonium from bone so that it will be accessible to the decontaminating action of Zr citrate.

Animals fed a diet very low in phosphorus have a continuous drain of phosphorus in the feces. This drain was increased four fold by adding hydroxide to the diet, thus increasing the loss of phosphorus from the body and the bones, and promoting bone resorption. The effect of dietary aluminum hydroxide on the actual absorption of radio-phosphorus from the gut is also being studied.

The following activities were carried out in the radio-chemistry section. Pa^{230} and Pa^{233} was treated for the separation of U^{230} and U^{233} which had grown out after 25 days. The TTA containing the Pa was then diluted to .02 M in benzene and extracted three times with concentrated HNO_3. Approximately 9 millicuries of Pa was obtained. Work has progressed in the identification of the solution received from Oak Ridge said to be europium. A silver target was received and work started for the separation of radio-cadmium. During the month, a solution of radio-praseodymium was received from Oak Ridge and identification of this was made. A magnesium target was milled off and prepared for shipment from this laboratory.

Medical Physics

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Part B. Project 48A-II

Marrow Transplantation. The marrow transplantation experiments which have been described in previous reports are being continued. Curtis-Dunning and Slonaker rats have been treated both with benzene and x-ray in order to achieve a state of marrow depression previous to the transplantation of marrow from other rats of the same strains. X-ray was given in doses of 500 roentgens of total body radiation. Control rats have been subjected to mock surgical procedures after previous treatment with either benzene or x-ray. The results of these most recent experiments have not been completely gathered; however, definite growth of femoral and tibial marrow has been found in various implant sites as long as thirty days after operation. Some of the animals have been carried 65 and 70 days post-operatively, but biopsy material has not been prepared as yet for examination.

These experiments were designed to develop techniques and secure basic information about the behavior of marrow implants, particularly in regard to their survival times. The experimental procedure has consisted of the implantation of healthy rat marrow into liver, muscle and subcutaneous tissue of rats of the same strain and of other strains which have had previous treatment with either radiation or chemical hemopoietic depressant drugs. Peripheral blood count data is being accumulated.

Radiomicrobiology. Two strains of E-coli, Strain B and Strain B/r, were obtained from Miss Evelyn Witkin. Sensitivity studies which we had performed with various strains of B-coli have been carried over to these two strains in an attempt to throw some light on the nature of radiation sensitivity and radiation resistance of bacterial cells. Our data has corroborated Witken's findings that B/r has a markedly greater resistance to the lethal effects of ultraviolet light than the parent strain B.

An interesting result was obtained when B/r was aerated for an hour at 37° C. in water before exposure to ultraviolet light: Whereas the original survival curve was a sigmoid, or "multiple-hit," curve, a straight line or "single-hit" survival curve was obtained after the aerated water treatment.

Various staining methods and phase microscopy are being employed in the attempt to determine the relationship of bacterial cytology to radiation sensitivity. Interesting data is being gathered relating the age of culture during the first few generative cycles and the sensitivity of the culture to radiation.

10. Health Physics and Chemistry

Slow neutron flux densities have been measured by foils placed at various depths in the concrete shielding of the 184-inch cyclotron at particular locations. The values fall through a range of 5×10^4 in passing from the inside to a point one foot from the outer surface. From this point to the outside the values rise again by a factor of between 5 and 10, probably due to the neutron atmosphere outside the walls arising from air scattered neutrons which originally leaked through the two foot shielding roof. Under the strongest beam conditions the slow neutron flux in the air outside the walls is less than 100 per square centimeter per second. The fast neutron flux is measured to be much below tolerance.

Following is a list of the current projects under development in the Research and Development Section and a statement regarding the progress of each:

a. Beta-gamma lead-shielded gloved box: Rubber socks put on ball-socket manipulator. Trial run made by S. G. Thompson; full-scale run awaiting completion of Webb's target assembly. Binoculars for use on cave assembled.

b. Am target: Alternate 60" target assembly completed; used to bombard 1 mg Am in the microinterceptor.

c. Yttrium milking for Dr. Gofman: A mounted serum bottle-capping device has been completed.

d. Conway shielded electrode holder (arc source): Design is almost complete on a new model.

e. Milling machine for active samples: Protective equipment almost completed.

f. Decontamination chamber: Two plans have been discussed--"box" and "room with diving suit". Hydraulic lift being considered possibly for the latter.

g. "Cow" for periodic extraction of americium from plutonium: Cold runs were made in spinner columns with hexone and ammonium nitrate solution. Centrifilters are being set up in CRL, Room 205.

h. Miscellaneous equipment: Work was done on steel tape manipulator, hydraulic manipulator, portable alpha-counter case, micro heat lamps, constant temperature baths, alpha finger probe, and concentric vernier syringe.

Information Division
6-9-48/hw

May, 1948

APPROXIMATE DISTRIBUTION OF EFFORT

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
1. 184-inch Cyclotron	Operation	10.5	
2. 60-inch Cyclotron	---	---	Non-Project
3. Synchrotron	R.f. System	3.8	
	General	0.3	
	Injection	2.0	
	Miscellaneous Equipment	2.0	
	Magnet Tests and Operation	2.0	
	Vacuum Chamber	1.0	
4. Linear Accelerator	Linear Accelerator-General	5.0	
	Van de Graaff General	7.0	
	General, Development, etc.	0.5	
5. Experimental Physics	Cloud Chamber	5.0	
	Film Program	3.3	
	Ionization Chamber and Crystal Counter	0.8	
	Neutron-proton Scattering	2.0	
	Proton-proton Scattering	2.0	
	Neutron Diffraction	0.5	
	Delayed Neutrons	2.0	
	Meson Counting	1.0	
	Absolute Cross Section Measurements	1.0	
	Neutron Half Life	0.5	
	Bevatron Design Studies	0.5	
	General Physics Research	6.0	
	Magnetic Measuring Equipment	0.5	
	Bevatron Magnet	5.5	
6. Theoretical Physics	Synchrotron	0.3	
	Bevatron	1.5	
	Cyclotron	0.5	
	Linear Accelerator	0.3	
	General Physics Research	7.6	
7. Isotope Separation	JA Conversion	1.5	
	Nier Spectrometer	1.0	

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENT
8. Chemistry. Part A	Chemistry of Transuranic Elements	5.0	
	Nuclear Properties of Transuranium Elements	3.5	
	Transmutations with the 184-inch Cyclotron	6.0	
	Transmutations with the 60-inch Cyclotron	1.0	
	Analytical and Service	14.5	
	Chemistry of Astatine	1.5	
Chemistry. Part B	Synthetic and Experimental Organic Chemistry	6.6	
	Biological Chemistry	4.8	
	Photosynethetic Chemistry	6.8	
Chemistry. Part C	Metals and High Temperature Thermodynamics	2.5	
	Basic Chemistry, including Metal Chelates	3.5	
	General	2.0	
9. Medical Physics. Part A	Evaluation of Metabolic Properties of Plutonium and Allied Materials in Animal and Man	13.0	
	Decontamination Studies	7.0	
	Radiochemistry	1.0	
	Radioautography	2.0	
Medical Physics. Part B (Project 48A-11)	Uranium Research	0.5	3.0 Consultant Man-Month
	Tumor Metabolism	0.3	0.5 "
	Special x-ray Studies, Radioactive Measurements, etc.	0.5	---
	Radioactive Carbon Studies	0.3	---
	Fundamental Medical Research	0.5	1.0 "
	Hematology	---	0.5 "
	Medical Work with 184-inch Cyclotron	0.5	0.5 "
10. Health Physics and Chemistry	Monitoring and Special Problems	6.0	
	Salvage, Decontamination, Disposal, etc.	3.4	
	Research and Development	8.0	