This document consists of 14 pages
Copy 24 of 27 : Series B.

SECRET

M-1945

THE UNIVERSITY OF ROCHESTER

II-186-

Manhattan Project

728592

Contract W-7401-eng-49

Division: Radiology and Biophysics

Division Head: William F. Bale

MONTHLY PROGRESS REPORT FOR JANUARY 1947

January 1947

Part II — Contents

Instrumentation ..... John B. Hursh

Tracer Chemistry ..... Robert M. Fink

Radiation Physiology ..... Thomas R. Noonan

Radiation Chemistry ..... Kurt Salomon

Spectroscopy ..... Luville T. Steadman

Radiation Mechanics ..... Francis W. Bishop

Metabolism ..... Samuel H. Bassett

DEPARTMENT OF ENERGY DECLASSIFICATION REVIEW
SINGLE REVIEW AUTHORIZED BY: DOE/HQ/OD Appt 1/1/96
DETERMINATION [CIRCLE NUMBER(S)]
1. CLASSIFICATION RETAINED
2. CLASSIFICATION CHANGED TO:
3. CONTAINS NO DOE CLASSIFIED INFO
4. COORDINATE WITH:
5. CLASSIFICATION CANCELLED
6. CLASSIFIED INFO BRACKETED
7. OTHER (SPECIFY):
REVIEWER (ADD):
NAME:
DATE: 8/20/96

Submitted by: Andrew H. Dowdy, M. D.
Director

Report received: 2/15/47
Issued: FEB 24 1947

8005311

Classification Cancelled
~~Or Changed To~~
By Authority Of Div. of Classification
By [illegible] Date 5/10/74

TABLE OF CONTENTS

		Page No.
1.	Instrumentation	3
1.1	Instrumentation	3
1.2	Measurement of Radon in Breath Samples	3
1.3	Routine Service and Analysis	3
2.	Tracer Chemistry	3
2.1	Polonium Metabolism	3
2.2	Radioisotope Studies	3
2.3	Uranium Metabolism	8
3.	Radiation Physiology	8
3.1	Effects of Very High Dose, Single Exposure to X-irradiation	8
3.2	Effects of Chronic X-irradiation Upon the Susceptibility to Acute Exposure	9
3.3	Relationship between Body Weight and Survival Time after Acute Irradiation	11
3.4	Radioautographic Technique	11
3.5	Coordinated Research Program	12
4.	Radiation Chemistry	12
4.1	Experiments on Blood Calcium Levels in Pigeons After Irradiation with X-Ray	12
4.2	Experiments on Bone Formation in Pigeons after Irradiation with X-Rays	13
4.3	Experiments Pertaining to the Counting of Radioactive Calcium	13
5.	Spectroscopy	13
5.1	Deposition of Heavy Metals in Bone	13
5.2	Infra-red Spectroscopy	14
5.3	Service Analyses	14
6.	Radiation Mechanics	14
6.1	Animal Radiography	14
6.2	Electron Microscope	14
7.	Metabolism	14
7.1	Uranium in Human Subjects	14

8005312

1. Instrumentation

Section Head — John B. Hursh

1.1 Instrumentation

An audio-oscillator with a resistance-capacitance tank circuit, a frequency range from 11 c.p.s. to 65,000 c.p.s., and an output of 10 millivolts to 7 volts suitable for feeding into a high impedance has been built for general testing purposes.

1.2 Measurement of Radon in Breath Samples

Included in this report are 4 graphs showing the radioactivity of radon and its decay products as a function of time. Similar curves and the general equation from which the present curves are calculated can be found in "Radiations from Radioactive Substances", by Rutherford, Chadwick, and Ellis.

1.3 Routine Service and Analysis

1. Project radioactivity apparatus was maintained in operating condition.

2. Two Rochester Ion Meters were repaired and recalibrated for use by a District special materials plant.

3. The following analyses were made:

   a) 78 air samples for radon content.

2. Tracer Chemistry

Section Head — Robert M. Fink

2.1 Polonium Metabolism

Dog metabolism cages in which contact of excreta with metal is minimized have been set up and are being used for collections of excreta. After some preliminary work, the excretion of polonium by dogs will be studied with a view to setting up a colony of dogs with a low, approximately constant polonium content maintained by repeated injections at intervals of a week or more.

2.2 Radioisotope Studies

The use of filter paper partition chromatography[1] as an accessory tool in the study of intermediary metabolism with radioisotopes is being studied and appears to show promise for experiments with small animals. The procedure was originally worked out for the qualitative analysis of amino acids[1] and has been tried with

1. Consden, R.; A. H. Gordon and A. J. P. Martin: Biochem. J. 38, 224-232 (1944)

8005313

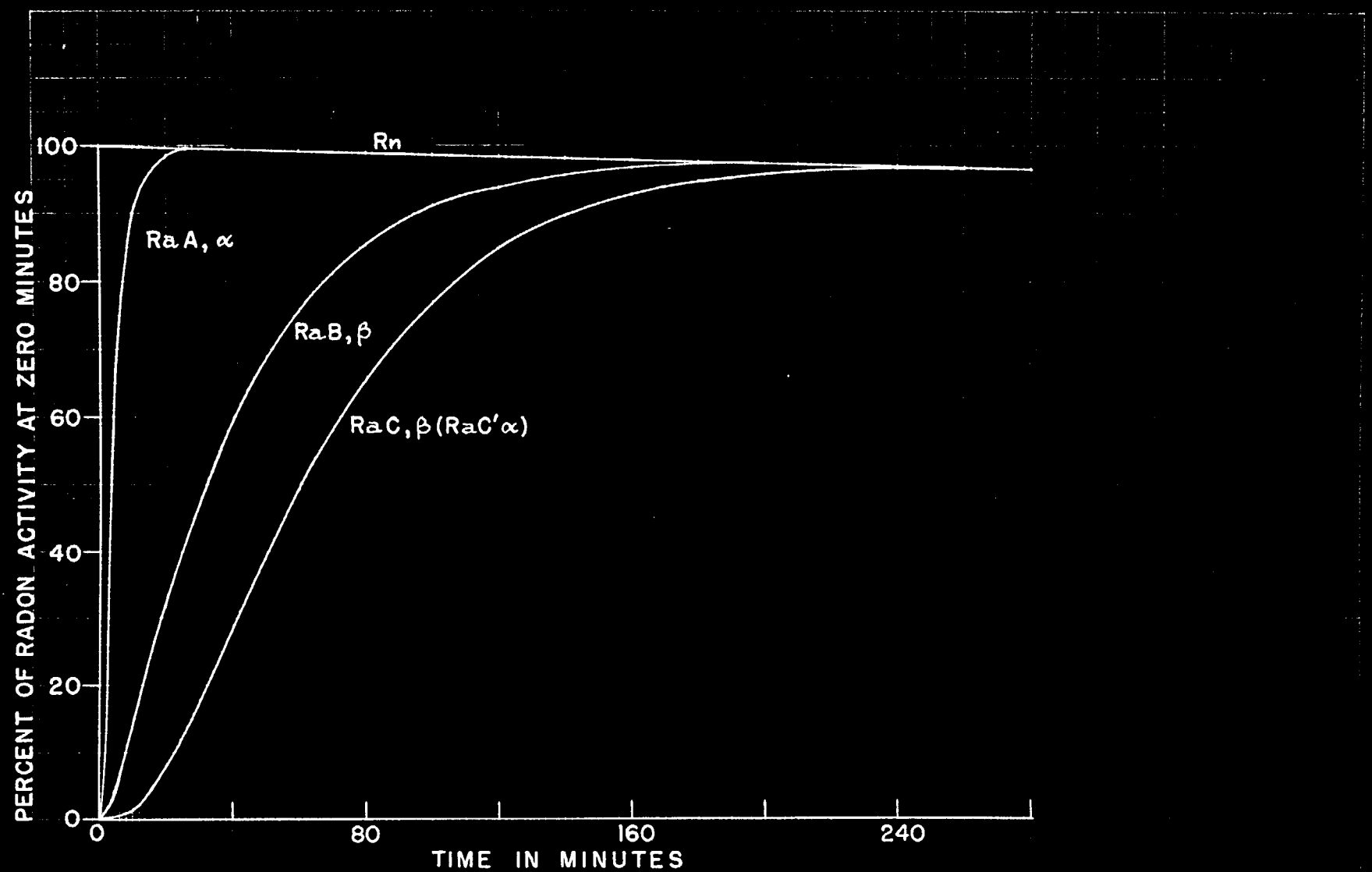

Figure I. Radon gas is introduced into a closed chamber at zero minutes and the activity of radon, Ra A, Ra B, Ra C is plotted as a function of time. Because of its 10^{-6}-second half-life, Ra C' has essentially the same activity as Ra C.

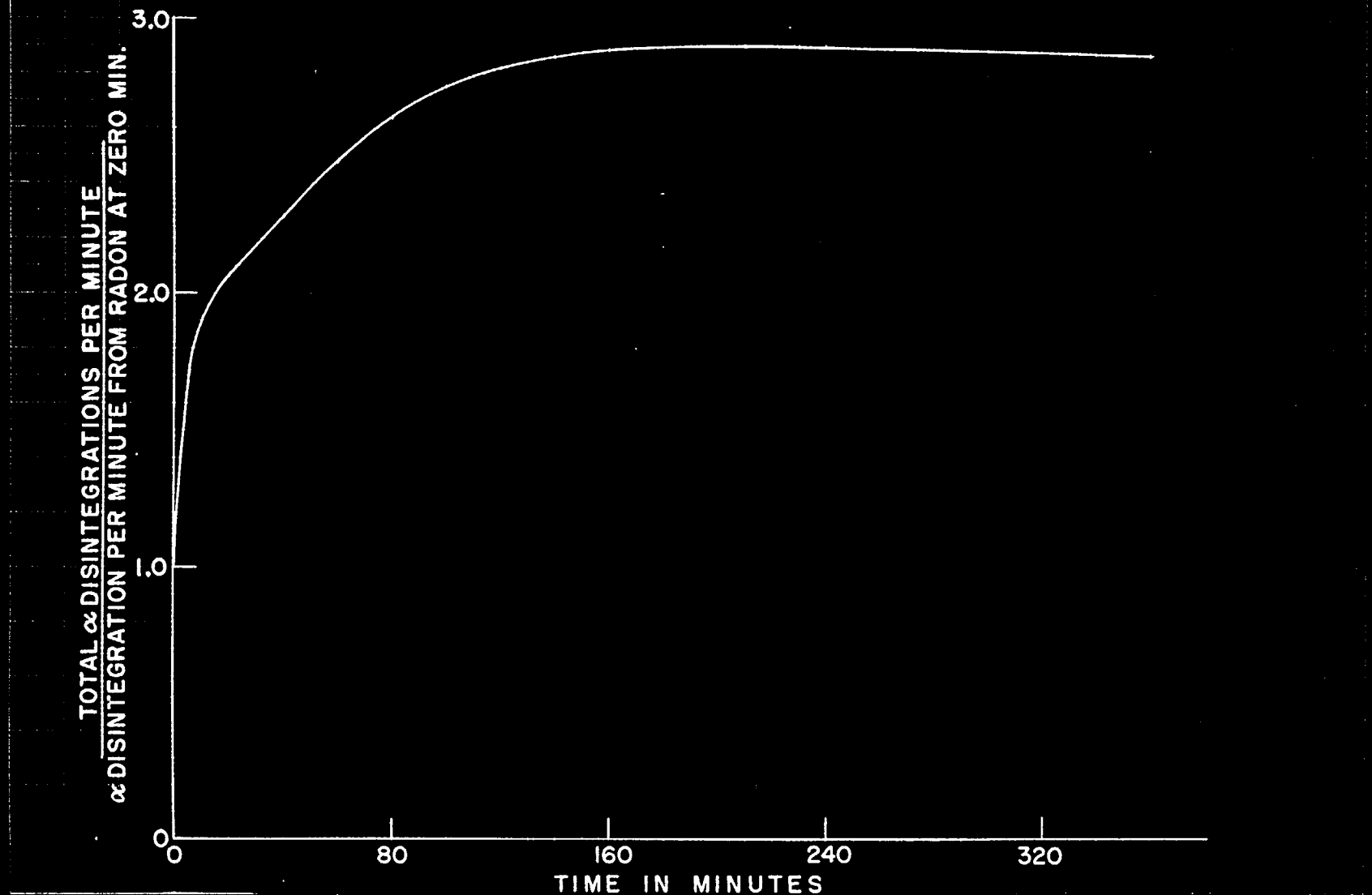

Figure II. Radon is introduced into a closed chamber at zero minutes and the sum of the alpha disintegrations from radon, Ra A, and Ra C' are plotted as a function of time.

8005315

SECRET

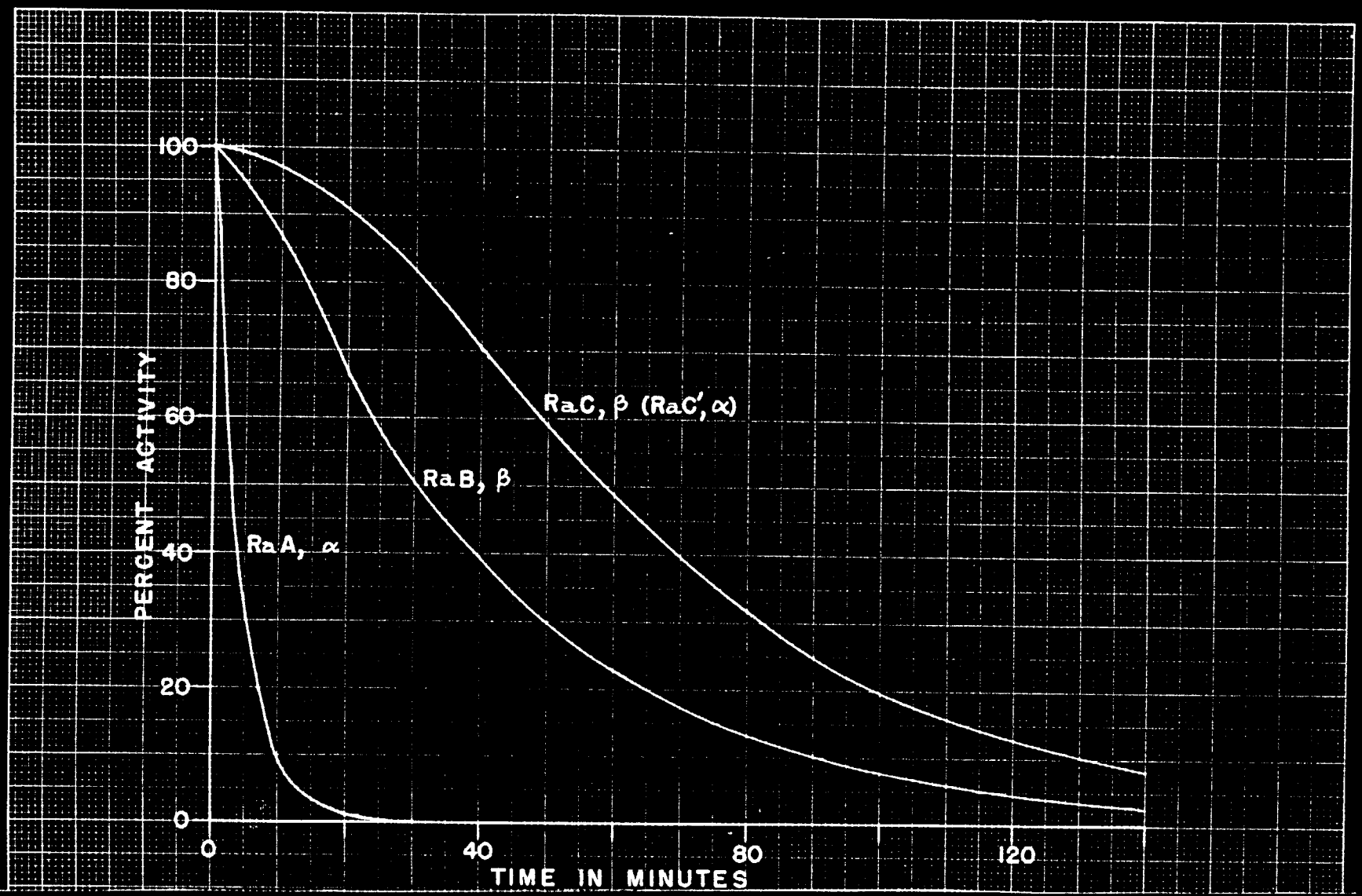

Figure III. The radioactive decay of Ra A, Ra B, and Ra C under circumstances in which a transient equilibrium has been established between radon gas and these decay products in a closed system and the radon has been removed at zero minutes. Because of its 10^{-6}-second half-life, Ra C' has essentially the same activity as Ra C. It should be noted that no account has been taken of radon decay during the preliminary equilibration period.

0035316

SECRET

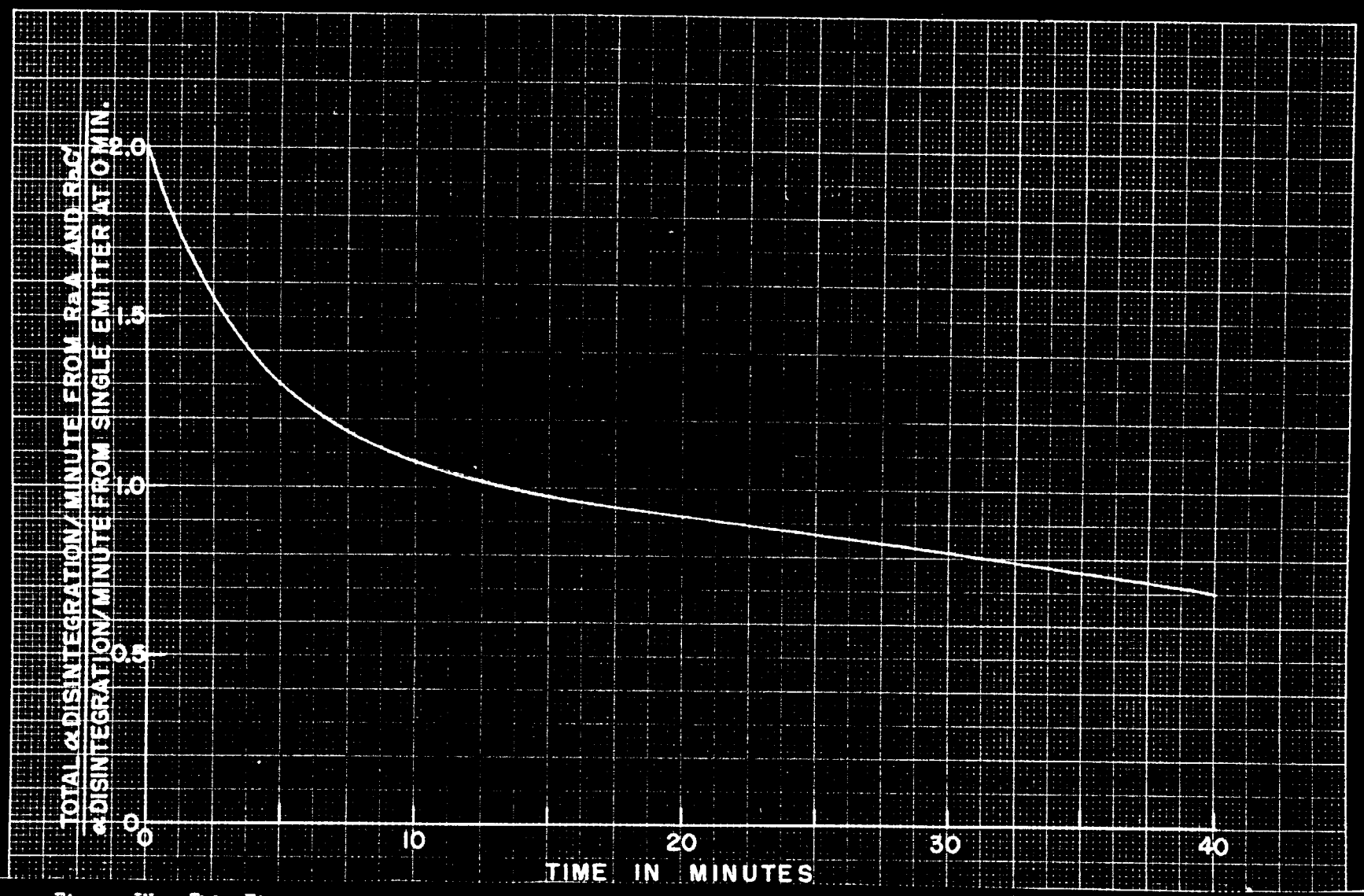

Figure IV. This Figure shows decay of alpha activity from Ra A and Ra C' under circumstances in which these disintegration products were brought into transient equilibrium with radon gas in a closed system. At zero minutes the radon was removed. It should be noted that no account has been taken of radon decay during the preliminary equilibration period.

UNCLASSIFIED

reducing sugars[2] and inorganic compounds. Experiments in our laboratory with the filter paper partition chromatography of organic acids, their salts, and their potassium hydroxamate derivatives indicate that the procedure may also be adaptable to this important class of intermediary metabolites.

As a preliminary experiment in combining filter paper chromatography with radioisotope studies, carrier-free I^{131} was administered to a rat; the animal was sacrificed after 24 hours, and its thyroid hydrolyzed with $Ba(OH)_2$. After preparing a two-dimensional chromatogram of an aliquot of the hydrolyzate with phenol and collidine, the filter paper square was left in contact with a photographic film for three days. Upon development the film showed definite exposure at the spots corresponding to the positions of inorganic iodide, diiodotyrosine, and thyroxine.

2.3 Uranium Metabolism

Further studies on a sixth human subject are reported in the section on Metabolism.

3. Radiation Physiology

Section Head — Thomas R. Noonan

3.1 Effects of Very High Dose, Single Exposure to X-irradiation

The effect of varying the intensity of radiation upon survival time after high doses or X-irradiation has been studied.

One preliminary experiment was performed upon a group of rats which had survived a dose of 850 r given more than 60 days earlier. The results of this experiment are presented in tabular form below:

Table I

Group	Total Dose (r)	Intensity (r/min.)	Survival Time (hours after start of irradiation) Mean	Standard Deviation
150 RBH I	15,000	313-345	77.65	18.70
150 RBH II	15,000	70	98.23	11.15
220 RBH I	22,000	308-329	42.83	10.66
220 RBH II	22,000	70	58.10	8.22
300 RBH I	30,000	323-352	21.25	10.92
300 RBH II	30,000	70	36.87	8.44

2. Partridge, S. M.: Nature 158, 270-271 (1946)

Another experiment was done with stock rats without previous irradiation.

These result are presented in tabular form below:

Table II

Group	Total Dose (r)	Intensity (r/min.)	Survival Time (hours after start of irradiation) Mean	Standard Deviation
300 RED	30,000	313-392	22.80	12.15
300 WDT	30,000	78-80	45.53	3.90
100 RED	10,000	361	93.83	6.98
100 RED	10,000	66.5-68	89.80	7.11
20 RED	2,000	361	73.33	2.75
20 WDT	2,000	71	73.79	5.67

The Statistics Division has computed "t" ratios for the differences in the means of the above groups. For a dose of 30,000 r the difference in mean survival times between groups 300 RED and 300 WDT is significant ($P < 0.01$). For the doses of 2,000 r and of 10,000 r the differences in means are not significant.

3.2 Effects of Chronic X-Irradiation Upon the Susceptibility to Acute Exposure

The first experiment designed to study the effect of daily exposure to small doses of radiation upon susceptibility to acute irradiation has been completed. The results have been reported piecemeal in previous monthly reports but are now gathered together in order to present the data more clearly.

A. Methods:

Rats were furnished by the Bronson Avenue Laboratory. The animals were young adults, equally divided as to sex. They were housed two to a cage and fed Purina Fox Chow, supplemented by Fox Blox, and had free access to water. Irradiation was done while the rats were in their regular cages. The control rats were transported to and from the X-ray room but were not taken into the room. There was no death among any of the animals until after their exposure to acute radiation.

The factors involved in the chronic radiation were:

Voltage - 250 kilovolts.
Filament current - 8 or 15 milliamperes.
Filter - Aluminum parabolic (23.2 mm. thick at center)
Half value layer - 2.1 mm. of copper.
Target - skin distance - 3.3 meters.
Time of exposure - 31-33 minutes.

The rats were divided at random into three groups, each consisting of 10 males and 10 females. The group designations and the treatment received are

80053319

Table III

Group	Treatment
NCA I a.	10 r/day for 50 exposures.
NCA I b.	10 r/day for 100 exposures.
NCA II.	20 r/day for 50 exposures.
NCA Control a.	0 r/day for 50 exposures.
NCA Control b.	0 r/day for 100 exposures.

Groups NCA I a and NCA I b were exposed together during the first 50 exposures. The dose was varied by varying the milliamperage, the time of exposure being practically the same for all radiated animals.

The day following completion of the scheduled number of exposures, irradiated and control animals were exposed to 600 r of X-irradiation in groups of 16 animals. Both irradiated and control animals were included in each group receiving acute doses of irradiation.

The radiation factors for this acute exposure were:

Voltage - 250 kilovolts.
Filament current - 15 milliamperes.
Filter - Aluminum parabolic (14.2 mm. thick at center)
plus 0.5 mm. of copper.
Half value layer - 2.1 mm. of copper.
Target-skin distance - 61 cm.
Time of exposure - 32-33 minutes.

During the last two weeks before acute radiation, white blood counts and hemoglobin determinations were done on randomly chosen animals from each group.

B. Results:

The results are presented in Table IV.

Table IV

Group	Exposure	Leukocyte Count (per. cu. mm.) Mean	Std. Dev.	Cumulative Group Mortality 15 days	30 days	60 days
NCA I a.	50 x 10 r	14,312	5,460	3	3	3
NCA II.	50 x 20 r	9,862	1,180	1	2	3
NCA Control a.	50 x 0 r	23,912	4,615	4	4	4
NCA I b.	100 x 10 r	14,525	7,061	8	9	10
NCA Control b.	100 x 0 r	22,281	7,557	4	6	8

Hemoglobin values did not seem to differ significantly among the various groups.

Although the mortality seems to be higher in both groups NCA I b and NCA Control b than in the first three groups, this difference is not significant when the data are tested by the "Chi-square" test.

The conclusion which may be drawn from this experiment is that exposure to 500 r or 1000 r (in daily doses of 10 or 20 r) will depress the leukocyte count but will not make the exposed animals any more susceptible to a subsequent exposure to a single dose of 600 r. The experiment is being repeated with slight modifications in order to check this rather unexpected result.

3.3 Relationship between Body Weight and Survival Time after Acute Irradiation

Under the immediate supervision of Miss Mildred Taylor, experiments are being continued to investigate the effect of body weight upon survival time after lethal doses of X-irradiation.

Previous experiments have been reported in the monthly reports for November and December. A third experiment is reported below:

X-irradiation 600 r whole body, 250 KV., H. V. L. = 2.1 mm. of copper

Group	Number of Animals	Mean Body Weight (grams)	Mean Survival Time (hours after start of irradiation)
A	24	47.2	130.0
B	24	86.8	142.5
C	12	125.2	256.4
D	12	124.8	282.9*
E	12	292.8	166.9
F	12	185.0	214.5

* 83.3% mortality, mean survival time based only on animals which died.

The report of a similar experiment in the monthly report for December contains an error in that the H.V.L. is reported as 2.1 mm. of copper. The correct figure for the H.V.L. in that experiment should be 0.4 mm. of copper.

3.4 Radioautographic Technique

Mr. George Body is continuing studies on methods for improving the resolution of radioautographs. A double stage for the microscope comparator was completed and found satisfactory for "high dry" magnification. With some changes in design, it is hoped that the instrument can be used at even higher magnifications.

During the course of this work, it was discovered that polonium seems to be removed from a tissue during the staining process. This matter is being investigated in more detail to determine if any particular step in the routine

8005321

hematoxylin and eosin staining method is specific for the removal of this element from tissue.

3.5 Coordinated Research Program

Studies on effects of X-irradiation on pigeons are being made in cooperation with the Radiation Chemistry section and are being reported in greater detail by Dr. Solomon. Miss M. E. Gould of this section has made hematological and bone marrow studies in connection with this problem.

Routine animal care and exposures to X-irradiation have been provided for other sections.

4. Radiation Chemistry

Section Head -- Kurt Solomon

4.1 Experiments on Blood Calcium Levels in Pigeons After Irradiation with X-Ray

The influence of irradiation on mobilization of calcium from the skeleton as well as on calcium deposition has been studied in only a few instances. An increase, as well as a decrease in excretion of calcium after irradiation with X-Rays has been reported in the literature. The deposition of calcium in tumors as well as in normal tissues after irradiation has also been reported. Rise in the blood calcium level, as well as a fall of it, has been found by various workers; others have found no influence of irradiation on blood calcium levels.

In view of this contradictory data, we thought it of interest to study blood calcium levels in the blood of birds. Preliminary experiments were carried out with pigeons. The results obtained are noted below:

Pigeon #C-1
(Irradiated with 3000 r)

Before irradiation (control calcium value)	9.72 mg%
24 hours after irradiation	9.86 mg%
48 hours after irradiation	9.93 mg%

Pigeon #C-2
(Irradiated with 5000 r)

Before irradiation (control calcium value)	13.60 mg%
24 hours after irradiation	11.90 mg%
48 hours after irradiation	10.54 mg%

Comment: No significant change in the calcium levels of pigeon #C-1 could be found. In pigeon #C-2 decreased calcium levels were noted, but it should be mentioned that they are still within the range of fluctuation as normally found in pigeons. More animals would have to be tested at the 5000 r level in order to find out whether or not the reported findings are significant.

8005322

4.2 Experiments on Bone Formation in Pigeons after Irradiation with X-Rays

Experiments were designed for the investigation of the influence of X-Rays on bone formation in pigeons in the presence of sex hormones. Since it has been shown that bone marrow activity and the degree of response in newly-formed bone after the injection of sex hormones are interrelated, it seemed of interest to study this phenomenon after the irradiation of bone marrow with X-Rays. These experiments, in collaboration with Dr. Thomas R. Noonan, are now in progress.

4.3 Experiments Pertaining to the Counting of Radioactive Calcium

Various calcium salts were tested in order to find the calcium compound which forms a layer on the counting disc suitable for the counting of radioactivity in the Geiger Counter. Some of the experiments carried out are outlined below. Very satisfactory results were obtained with calcium chloride solutions dissolved in .04 normal hydrochloric acid and evaporated after neutralization on a silver foil. Some details of these experiments are given below.

$CaCl_2$ 0.09 g/1cc.

1/2 cc $CaCl_2$ plus 1/2 cc sat. $(NH_4)_2C_2O_4$.

1cc $CaCl_2$ = 0.09g plus 1 drop triton (1:30 dilution).

$CaCl_2$ dissolved in 2% HCl.

Calcium gluconate.

9000 micrograms Ca = 0.1 cc $CaCl_2$ plus 0.9 cc sat. $(NH_4)_2C_2O_4$.

$CaCl_2$ plus 3 drops aerosol/EtOH.

$(NH_4)_2CO_3$ plus NH_3 plus $CaCl_2$ ---> $CaCO_3$.

Diluted $Ca_3(PO_4)_2$.

$CaCl_2$ dissolved in 0.04 N HCl plus 3 drops NH_3.

5. Spectroscopy

Section Head -- Luville T. Steadman

5.1 Deposition of Heavy Metals in Bone

A few trial photographic exposures have shown that, with No-screen x-ray film, bone ash containing 1% uranium gives a barely detectable image in 24 hours but a weeks exposure is required to obtain a good image. Bone ash with 1% uranium content, however, is markedly colored and may be readily distinguished by the eye from normal bone. Auto-radiography is therefore not necessary for identifying uranium in bone when the concentration is of the order of magnitude required for x-ray diffraction studies.

It has been mentioned before that similar concentrations of lead in ashed bone show the black color of the oxide. An even more sensitive test for lead in the bone is with H_2S.

The present procedure used with the bones containing heavy metals is to saw a fresh bone section in half so that one half may be ashed and used as reference, the other deproteinated and examined by x-ray diffraction.

5.2 Infra-red Spectroscopy

A technique, recently worked out for handling protein samples in the infra-red spectrometer, consists in forming a crystalline deposit of the protein on a base film of nitrocellulose by evaporation of the aqueous solvent. The films are prepared by putting a thin layer of collodion on two rock salt plates. When the film was dried and a pair of plates plus protective film have been made which have nearly the same transmission, one is used for the reference filler the other for holding the sample. Although cellulose nitrate has several absorption peaks in the infra-red, films may be secured thin enough and thus a high enough transmission to permit measurements on the protein specimen to the limit of the instrument, 15 microns. Most of the tests thus far have been with albumin.

5.3 Service Analyses

Several spectrographic analyses have been made on samples of beryllium ore and beryllium metal for Be, and Pb, U, Th, and others for the Pharmacology Division.

6. Radiation Mechanics

Section Head -- Francis W. Bishop

6.1 Animal Radiography

The installation of the animal radiographic machine has been completed. The apparatus was calibrated and techniques for the various animals established. The darkroom facilities are not completed due to lack of materials.

6.2 Electron Microscope

The large electron microscope was dismantled for cleaning and overhauling, as is necessary periodically, and is being reassembled. The balance of the month has been spent in construction of a high voltage power supply for use on both the small microscope and the condenser discharge unit. The metal evaporating unit has been finished and has been put into use for the preparation of electron microscope specimens and is very successful.

7. Metabolism

Section Head -- Samuel F. Bassett

7.1 Uranium in Human Subjects

Subject number six was admitted to the Metabolism unit on January 3, 1947. Experiments involving this subject are not yet complete because the rate of excretion is being tested both before and after acidification of the patient with ammonium chloride. Data will be completed in time for the February report.