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Manhattan Project

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Division: Radiology and Biophysics Division Head: William F. Bale

MONTHLY PROGRESS REPORT FOR OCTOBER 1946

William F. Bale

October 1946

PART II * CONTENTS

November 20, 1946

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

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1. Instrumentation

Section Head -- John B. Hursh

1.1 Instrumentation

1. Development work is being continued on:

   a. Apparatus to improve the measurement of the radon content of breath samples.
   b. An additional counting rate meter.
   c. A wide sensitivity range portable meter for measuring alpha, beta and gamma radiation.

2. A Geiger counter, including an a.c. power supply and a scale-of-100 counting circuit has been built and tested.

1.2 Routine Service and Analyses

1. Project radioactivity measuring apparatus was maintained in operating condition.

2. An inspection was made of two Manhattan District plants being placed in stand-by condition and a survey of radiation intensities carried out.

3. The following analyses were made:

   a. 1765 film badges for beta, gamma and neutron radiation.
   b. 27 air samples for radon.
   c. 9 breath samples for radon.
   d. 2 solutions for radium.
   e. 67 silver foil samples for alpha activity.

2. Tracer Chemistry

Section Head -- Robert M. Fink

2.1 Radioactive Carbon

Preliminary work with radioactive carbon is continuing.

2.2 Metabolism of Polonium

A group of experiments concerning the effect of BAL on polonium metabolism is being completed and will probably be ready to report next month.

2.3 Uranium Metabolism

Further studies on human subjects carried out by Dr. Frenkel of this section in collaboration with Dr. Bassett are reported in the section on metabolism.

2.4 MPTS Volume

A high proportion of time of the group is being expanded in shaping up the final draft of a volume for the Manhattan Project Technical Series.

3. Radiation Physiology Section Head — Thomas Noonan

3.1 Effects of Very High Single Exposures to X-irradiation.

The results reported in the monthly report for September are being studied statistically. A few additional experiments are being planned to fill in gaps in the survival time-dose curve.

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

The thirty-day mortality rate caused by an acute exposure to 600r of x-irradiation has been determined for rats exposed to daily x-irradiation at two levels and for control rats. The results are tabulated below.

Group	Number of Animals	Chronic Dosage	Percentage Mortality
NCA (control)	20	0	20
NCA I	20	50 x 10r	15
NCA II	20	50 x 20r	10

During the week prior to irradiation, complete blood counts were done on every fifth rat used in the experiment. The erythrocyte count and hemoglobin were not apparently different between the three groups. The average total leukocyte counts for the three groups were as follows:

Control	23,912±	Sigma = 4,615
10 r/day	14,312±	Sigma = 5,460
20 r/day	9,862±	Sigma = 1,180

A second group of rats are being exposed to 10r per day for a total of 100 treatments and will then be given an acute exposure.

On the basis of the above data, it would seem that daily exposure to x-irradiation sufficient to cause definite leukopenia does not make the rat more susceptible to an acute dose of 600r. Additional studies are contemplated.

3.3 Relationship Between Body Weight and Survival Time after Acute Radiation

Experiments are being planned to investigate the relationship between body weight and survival time after acute radiation in rats. Spangler

has reported such a relationship in mice. In some of our experiments with rats we have noted that, at one dosage level only, heavier rats seemed to have a longer survival time.

4. Radiation Chemistry

Section Head -- Kurt Salomon

4.1 Literature and Experimental Work

Mrs. B. Wescott Gabrio has started some preliminary experiments with radioactive calcium.

Dr. Salomon is continuing to compile material on the biochemical effect of radiation.

5. Spectroscopy

Section Head -- Luville T. Steadman

5.1 X-ray Diffraction Applied to the Study of Heavy Metal Deposition in Bone -- Herbert Mermagen and L. T. Steadman

In the report for July, M-1884, feeding experiments were described in which rabbits were given either uranium nitrate or lead acetate and vitamin D. The uranium fed animals have been maintained to date on a dose which although periodically increased has not been great enough to kill the rabbits. Lead fed animals, as stated before, have however, been sacrificed or have died and a concentration of 1% lead in certain parts of the ashed bone has been measured.

Samples of this bone containing one percent lead, dry ashed at 500° C, have now been examined by x-ray diffraction techniques. Several lines appear which do not seem to be present in samples of normal ashed bone.

On the other hand bone from the uranium fed animals, containing uranium in a concentration of 0.1% on an ash weight basis, does not differ from normal ashed bone at least in so far as the number of visually distinguishable diffraction lines is concerned.

The purpose of these experiments is to obtain, if possible, direct experimental evidence of the locations of uranium and lead in the bone structural lattice. It is recognized that the above ashing procedure is likely to produce important changes in this structure and even in the form and lattice location of heavy metals. However, this technique was adopted for preliminary work because it seemed to offer the greatest possibility of detecting low concentrations of these heavy metals.

To assist in the interpretation of these lead results and of any corresponding pictures that may be obtained for bone containing uranium, when samples of appropriate uranium concentration have been produced, a comprehensive series of diffraction pictures of control specimens is in the process

of being built up as follows:

a. Diffraction patterns have been made of bone specimens with known mixtures of uranium nitrate (0.1, 0.5, 1.0, 5.0 and 10% uranium content) to establish a measure of sensitivity.

b. Since the usual bone specimens are ashed at 500° C it is apparent that uranium might be present as an oxide and thus patterns were made of UO_2, U_3O_8 and UO_3.

c. Further studies involved the changes occurring in U-nitrate when heated by itself to corresponding ashing temperatures. It was found, from preliminary results, that uranium nitrate after the process of roasing reveals diffraction lines of U_3O_8 and UO_2 but none of UO_3. These lines are in similar positions as those from ashed bone, which results in a superimposition of diffraction intensities difficult to interpret without a densitometer. Such an instrument suitable for x-ray diffraction picture measurements is in the process of development.

d. Similar studies have been carried out with lead phosphate. After roasting, oxides of lead produce diffraction lines which have positions very closely related to some of the intense lines of bone ash.

e. Also related to the possible effects of dry ashing on the bone lattice components are experiments being conducted on bone that has had the organic material removed by treatment with ethylene glycol and KOH. Spectrochemical analyses show that some, but only about 10% of the stored lead is removed by this treatment.

5.2 Absorption Spectroscopy Applied to the Analysis of Organic Compounds of Possible Importance in the Study of the Biological Effects of Radiation -- L. T. Steadman and H. F. Thompson

A Bausch and Lomb medium quartz spectrograph and sector photometer with an acoustically shielded 15,000 volt a.c. iron spark source has been set up for measurements in the visible and ultra-violet. A Beckman IR 2 recording infra-red spectrophotometer has been received and is being set up for absorption measurements in the infra-red.

Our determinations to date in the u-v have been on material such as blood plasma from normal rabbits. The feasibility of quantitatively measuring all the plasma constituents by optical means either directly or by suitable chemical separations is being studied. Thus far, some preliminary records have been obtained on commercial samples and on samples prepared from rabbits blood. These substances include hemoglobin, fibrinogen, albumin, globulin (pseudoglobulin and euglobulin), biluribin, uric acid, creatinine, cholesterol, ascorbic acid; and urea, glucose and lactic acid which have no significant absorption. The protein fractionation thus far has been by the conventional methods of precipitation from salt solutions of suitable concentration.

6. Radiation Mechanics

Section Head -- F. W. Bishop

6.1 Time Intensity Relationship of X-ray Effect

The mortality data from the experiment to determine the time-intensity relation of x-ray effect with 1000 KV radiation given at the rate of 425 r/min. and 4.25 r/min. is under analysis in the Statistics section. The construction of the condenser discharge apparatus is held up due to the lack of materials and shop man-power.

6.2 Electron Microscope

Electron micrographs are being made as needed for the Division of Pharmacology as a part of their program of dust particle size studies.

Further developmental work is being done on the emission type electron microscope.

7. Metabolism

Section Head -- Samuel E. Bassett

7.1 Metabolism of Uranium in Human Subjects

The studies of uranium excretion have been continued. Two subjects have been followed. The work on one is completed and the second nearly so.

The result of the one completed study is reported here. This study was carried out in collaboration with Dr. Albert Frenkel of the section of Tracer Chemistry and Dr. William Neumann's group of the Division of Pharmacology and Toxicology.

Subject number three was a young white, unmarried female, aged 24, who was admitted on 9/19/46 and discharged on 10/22/46. She was essentially normal except for chronic undernutrition which probably resulted from emotional maladjustments. On a program of moderate over-feeding, she gained 2 kg. during her hospitilization. The general physical examination revealed T. 37, P. 80, B. P. 100/60, Ht. 155.5 cm., Wt. 37 kg. The only finding of note was undernutrition.

At 10:40 A. M., October 1, 1946, she was injected with 5 ml. of physiological sodium acetate buffer of similar composition to that administered to patients number 1 and number 2, containing 116.8 micrograms per milliliter or 584.0 micrograms total of uranium as uranyl-nitrate enriched in U^{235} and U^{234}. This dose represents 5.76 micrograms uranium per kilogram of body weight.

Urine and feces were analyzed for uranium both by the fluorescence method developed by Dr. Neumann and by the electroplating and alpha counting method developed by Dr. Frenkel. Only the results of the latter method are available for this report. Table I gives the urine values obtained by the alpha counting method. Feces were again negative; that is, no significant amount of uranium could be detected by the method of analyses employed.

Table I

Excretion of Uranium by Patient 3

Date	Hour	Time after Injection Hr.	min.	µgm uranium in specimen	Amount of uranium in specimen in % of Dose.	% of Dose excreted per ml. of urine.
10/1/46	1:20 p.m.	1	30	203.04	34.78	.1298
	6:00 p.m.	6	20	151.44	25.95	.0549
	9:25 p.m.	9	45	24.60	4.21	.0229
10/2/46	6:30 a.m.	18	50	22.00	3.76	.0098
	10:30 a.m.	22	50	2.80	.48	.00254
10/3/46	8:00 a.m.	46	50	6.66	1.14	.00077
10/4/46	8:00 a.m.	70	50	3.18	.545	.00031
10/5/46	8:00 a.m.	94	50	1.75	.30	.00019
10/6/46	8:00 a.m.	118	50	1.51	.26	.00019
10/7/46	8:00 a.m.	142	50	.725	.125	.00008
10/8/46	8:00 a.m.	166	50	.66	.115	.00008
10/9/46	8:00 a.m.	190	50	less than .5	less than .1	less than .00005
10/10/46	8:00 a.m.	214	50	less than .5	less than .1	less than .00007
Total excretion:				429.365	71.865	
Excretion during first 23 hours:				403.68	69.18	.0465
Excretion during 5 following days:				13.625	2.370	.00030

Table 2

Ratio of urinary amino acid nitrogen to urinary creatinine.

(analyzed by E. Berke and M. Cressmon.)

All day specimens

Date	Amino acid N / Creatinine
9/20-9/21/46	.26
9/21-9/22	.26
9/22-9/23	.27
9/23-9/24	.31
9/24-9/25	.27
9/25-9/26	.21
9/26-9/27	.30
9/27-9/28	.29
9/28-9/29	.27
9/29-9/30	.17
9/30-10/1	.23
Point of uranium administration	
10/1--10/2	.24
10/2--10/3	.24
10/3--10/4	.21
10/4--10/5	.22
10/5--10/6	.22
10/6--10/7	.25
10/7--10/8	.23
10/8--10/9	.22
10/9--10/10	.24

The following additional laboratory data were obtained on this patient:

Blood Counts

	9/27/46	Date	10/10/46
Red Blood Cells	4.59 million cu mm.		5.13
Hemoglobin	12.0 grams/100 ml.		not done
White Blood Cells	6,750 cu mm.		5,500
Differential Count			
Neutrophiles	70%		68%
Lymphocytes	20%		13%
Monocytes	5%		10%
Eosinophiles	3%		2%
Basophiles	2%		1%
Degenerate forms	0%	Stab cells	3%
	100%		100%

Blood Chemistry

	9/28/46	10/11/46
Serum Chloride	99 m. eq/liter	101
" CO_2	54 vols. percent	[illegible]
Blood Sugar	[illegible] mg/percent	72
Non-Protein Nitrogen	[illegible] mg/percent	[illegible]
Inorganic Phosphorus	[illegible] mg/percent	3.7
Alkaline Phosphatase	[illegible] Bodansky units/100 cc	1.3
Total Serum Protein	5.8 gm percent	5.3
Albumin	[illegible] gm percent	3.6
Globulin	1.7 gm percent	[illegible]
Total Bilirubin	0.36 mg/percent	0.37

Renal Function

(Dr. [illegible])

	9/25/46	[illegible]
Glomerular filtration rate --	118 ml/min.	117 ml/min.
Renal Plasma Flow --	595 ml/min.	658 ml/min.
Maximum Tubular Excretory Capacity -- (para amino hippuric acid)	71 mg/min.	not done

The subject [illegible] due to the injection of [illegible].

As indicated [illegible] the [illegible] creatinine ratio did not increase after the administration of [illegible], a finding similar to that [illegible].

Spot tests of the catalase activity and protein concentration of the urine were carried out before and after injection by Dr. [illegible] who reports zero readings for [illegible] and no increase in catalase.