

## 9905 P

## Quantitative Studies on the Effect of X-Rays on Neoplastic Cells.\*

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The contradictory reports on the effect of X-rays on cells of experimental tumors induced us to study the effect of X-rays quantitatively. Inbred mice and neoplasms that can be transmitted by the introduction of a few cells have been used in our studies.<sup>1, 2</sup>

The cell suspension was X-rayed in thin walled Carrel flasks. The factors of the irradiation were as follows: 130 K.V., 15 MA, 25 cm distance, 140 r/min; filter = 3 mm aluminum.

TABLE I.

No. of cells inoculated		No. of mice				
		Not irradiated	Cell suspension			
			Exposed to			
		500 r	1000 r	2000 r	4000 r	
1,000,000	Injected	—	6	8	12	12
	Successfully injected	—	3 (38)	1 (92)	0	0
10,000	Injected	11	8	8	—	—
	Successfully injected	11 (13)	0	0	—	—
100	Injected	12	8	—	4	—
	Successfully injected	9 (19)	0	—	0	—
1	Injected	12	—	4	—	—
	Successfully injected	1 (82)	—	0	—	—

The figures in parentheses give the average length of life in days, after inoculation.

Table I, a summary of 3 experiments with lymphatic leukemia of Strain Ak 5, indicates that the overwhelming majority of the lymphoid cells of this strain are destroyed by 500 r of X-rays administered *in vitro* and that only an occasional cell, if any, survives exposure to 1000 r.

Experiments made with the atypical cells of a mononuclear leukemia, Strain S 2<sup>3</sup> indicate that after irradiation with 5,000 r

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<sup>1</sup> Furth, J., and Kahn, M. C., *Am. J. Cancer*, 1937, **31**, 276.

<sup>2</sup> Kahn, M. C., and Furth, J., *Proc. Soc. Exp. Biol. and Med.*, 1938, **38**, 485.

<sup>3</sup> Barnes, W. A., and Furth, J., *Am. J. Cancer*, 1937, **30**, 75.

numerous cells remained viable and retained the ability to produce the disease, but cells irradiated with 15,000 r produced no leukemia. In a few experiments made the lethal dose of X-rays for different types of leukemic cells tested was intermediate between those of Strain S 2 and Strain Akf 5, that is, between approximately 1,000 and 5,000 r. There are no data in the literature on the quantitative effect of irradiation such as those presented above, and it is now generally believed that *in vitro* there is no conspicuous difference in X-ray susceptibility between malignant lymphoid and sarcoma cells.<sup>4</sup>

In 4 experiments made with a transmissible sarcoma of mice (Strain S 31), all of 12 mice injected with tumor tissue that had been exposed to 2,000 r of X-rays developed tumors, while all of 27 mice injected with tumor tissue exposed to from 4,000 r to 15,000 r remained healthy.

Tissue culture studies confirmed the findings of Bohn, Spear and others,<sup>5</sup> indicating that the destructive effect of X-rays becomes manifest only in the successive generations of cells. Unirradiated fragments of sarcoma cultured *in vitro* from 4 to 8 days readily produced tumors when injected in mice. Fragments of the same tumor irradiated *in vitro* in 2 of the above experiments with 4,000 r and 15,000 r of X-rays respectively and grown *in vitro* for a similar length of time failed to produce tumors when injected into mice. In one experiment a culture of the unirradiated sarcoma could be subcultured after 6 days but that exposed to 5,000 r units of X-rays failed to grow on subculture though it showed active growth immediately after irradiation.

A chicken sarcoma (Strain 11) transmissible by a filterable agent and exposed *in vitro* to 15,000 r units, produced tumor in 11 of 12 chickens grouped in 2 experiments. Tissue cultures were made with irradiated and unirradiated fragments of this and of another tumor induced by virus (Strain 13). The fragments of Strain 11 were exposed to 15,000 r, those of Strain 13 to 4,000 r of X-rays. The cultures from the irradiated tissues degenerated after approximately 14 days. The unirradiated tumor can be grown almost indefinitely. These experiments suggest that the virus in tissues exposed to 15,000 r is resistant to X-rays (*Cf.* 4).

*Summary.* The experiments described indicate conspicuous differences in susceptibility to X-rays among different neoplastic cells of mice. They support the opinion that X-rays so injure cells that

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<sup>4</sup> Concerning the literature on radio-resistance of viruses and leukemic cells of mice, *cf.* Jørgensen, O. K., *Acta radiol.*, Suppl. 29, 1936.

<sup>5</sup> *Cf.* Spear, F. G., *Proc. Roy. Soc.*, 1930, **106**, 44.

multiplication can proceed only for a few cell generations, after which they degenerate and die. Viruses producing neoplasms are far more resistant to X-rays and it seems probable that exposure *in vitro* to approximately 15,000 r units of X-rays distinguishes between virus-containing and virus-free neoplasms, the latter losing the ability to transmit the disease when exposed to 15,000 r units of X-rays *in vitro*. Viruses are unaffected by the amount of irradiation used in these studies. Irradiated sarcoma cells multiply for several days and then die. Hence, failure to produce the disease with irradiated neoplastic cells is the best evidence available thus far that the neoplasms of mice studied are not transmitted by viruses.

### 9906 P

#### Calcium Studies in the Newborn.

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The purpose of this investigation was to study the relationship between the calcium of the cord blood and that of the peripheral blood during the first 10 days of life. If a low cord blood calcium regularly were associated with a low calcium during the first 10 days of life, then hypocalcemic tetany of the newborn could be predicted and prevented. In the 47 cases thus far examined there is a rather constant relationship between the cord and the postnatal blood though not of the nature mentioned above. There is a tendency for the serum calcium to assume values lower than the cord blood during the first 4 days of life and then to rise toward the pre-natal level during the next 5 days.

The average calcium of the serum of cord blood was 11.60.

The average deviation of peripheral blood from cord blood of the same individual was

—1.04	for the 1st to 2nd days	(11 cases)
—1.21	'' '' 3rd '' 4th ''	(16 '' )
—0.36	'' '' 5th '' 6th ''	( 8 '' )
+0.55	'' '' 7th to 9th ''	(12 '' )

While this work was in progress Bakwin<sup>1</sup> reported similar find-

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<sup>1</sup> Bakwin, H., *Am. J. Dis. Child.*, 1937, **54**, 1211.