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Comparison of the Reducing Power of Cancer Tumors and Tumors Produced by Filterable Viruses.

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There are in the literature contradictory reports with regard to the reducing power of tumor tissues. While Drew[1] and Heinlein[2] speak of a diminution of the reducing power of malignant tumors when compared to normal tissues, Voegtlin, Johnson and Dyer[3] maintain that such diminished power does not exist. Yaoi and Nakahara,[4] working with Rous chicken sarcoma, report that while this tumor when heated to 56° for half an hour and then incubated at 37°C. under a layer of vaseline, is unable to reduce methylene blue in the presence of sodium succinate, skeletal muscle submitted to the same treatment reduces the dye in 16 hours.

We have studied the reducing power of tumor tissues using the following technique. The tissue was cut in a manner similar to the Warburg technique for tissue respiration. This was placed in M/15 Sorensen's phosphates pH 7.38. Methylene blue was mostly used as indicators of reduction intensity. A stream of purified nitrogen was passed through the tubes. This kept the tissues in continuous movement throughout the entire column of liquid and facilitated the reduction of the dye. Rubber connections were entirely eliminated from the system. The tubes were kept in an air bath at 37.5°C.±0.3.

Seven different strains of rat's malignant tumors and one rabbit tumor have been studied. Our results show that tumor tissues have practically the same reducing power as normal tissues. When an easily oxidizable substrate (in our experiments sodium succinate) is added to the medium, the time of reduction is shortened, thus showing in all of these tumors the presence of the enzyme (succinodehydrogenase) which activates biological oxidation-reduction systems.

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[1] Drew, A. H., *Brit. J. Exp. Path.*, 1920, **1**, 115.

[2] Heinlein, H., *Z. f. Krebsforschung*, 1930, **30**, 506.

[3] Voegtlin, C., Johnson, J. M., and Dyer, H. A., *J. Pharm. and Exp. Therap.*, 1925, **24**, 305.

[4] Yaoi and Nakahara, *Proc. Imp. Acad.*, 1927, **3**, 102.

TABLE I.

Tissue	Time of complete reduction of methylene blue in minutes	
	With Na succinate	Without Na succinate
Rat Walker round cell sarcoma No. 319.	9	14
" " medullary carcinoma No. 256.	14	20
" " spindle cell carcinoma No. 155	25	30
" " carcinoma No. 2	10	15
" " adenocarcinoma No. 12	9	14
" " benign breast adenofibroma	17	22
" Crocker small spindle cell sarcoma	10	—
Rabbit epithelioma	23	—
Rous chicken sarcoma	114	114
Chicken muscle	14	24
Rabbit testicle—normal	23	—
" " virus III	36	—
" " neurovaccine	63	83
" brain—herpes	29	37
" " normal	14	19
Fowl—*Epithelioma contagiosum* (eye)	52	90
" " " (skin)	47	—
" normal skin	47	60
Rabbit myxoma	no reduction	no reduction

Tumors produced by filterable viruses show a striking contrast in their behavior towards the reduction of reversible dyes when compared to malignant tumors. Rous chicken sarcoma and rabbit myxoma have been studied. In addition to these tumors we have studied the reducing power of tissues where some filterable viruses were growing, namely, herpetic encephalitis (brain) rabbit virus III (testicle), neurovaccine Levaditi (rabbit testicle), and *epithelioma contagiosum* (fowl's eye and skin). As can be seen in Table I, both rabbit myxoma and Rous chicken sarcoma lack succinodehydrogenase and at the same time show lower reduction power than malignant tumors. Rabbit myxoma at the end of 5 hours reduces only 40% of 2-6-dichlorophenolindophenol (which would mean an E_0 of +0.158 volts). Tissues where filterable viruses are grown, show also a diminished power of reduction when compared to normal tissues, with the exception of *epithelioma contagiosum.* In this particular case there was a great amount of normal skin. Succinodehydrogenase was still present although there is a partial inhibition of the enzyme as shown by a slower rate of reduction.