animal that possesses invertase and utilizes sucrose in its diet.

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Malignant Tumors Resulting from Embedding Plastics in Rodents[1]

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In two previous communications (*1*, *2*) we have described various types of sarcomas which were induced in rats and mice by embedding certain plastic films in the anterior abdominal wall just ventral to the fascia. The initial observations were made on rats in which one kidney had been wrapped in cellophane to produce hypertension. Seven of these rats, autopsied after nearly 2 yr, were found to have developed sarcomas around the wrapped kidney. Later experiments showed that subcutaneous embedding produced similar results and the abdominal wall technique is now generally used by us.

In addition to cellophane (regenerated cellulose) we have embedded a number of other plastics and have produced malignant tumors in a considerable percentage of the animals. These are all long-term experiments lasting usually 1–2 yr before the appearance, if at all, of a sarcoma. The final results of some of these experiments cannot be reported as yet, since in many cases the time elapsed after embedding has not been sufficient for the appearance of tumors.

Nevertheless there are practical reasons for publishing further results now, as plastics are being used more and more extensively on humans by surgeons and surgical specialists. It is, however, very important to note that so far there is no proven instance in the literature of a malignant tumor induced in man by embedding a plastic. (Paraffinomas are foreign-body reactions, not malignant growths.) On the other hand, oncologists have reminded us that if it takes 1–2 yr for a malignant tumor to appear in a rodent, it may take 10–15 yr for a similar result in a human being.

TABLE 1

TUMORS OBTAINED BY EMBEDDING PLASTICS SUBCUTANEOUSLY

Completed Experiments

Material	Animals	Malignant tumors produced	
		No.	%
Cellophane A	Rats	15/42	35.7
Cellophane A	Mice	8/35	22.8
Cellophane A	Mice (black)	1/22	
Cellophane B	Rats	20/44	45.4
Polyethylene A	Rats	10/80	12.5
Pure polyethylene	Rats	7/38	18.4
Pure polyethylene	Mice	3/29	10.3
Polyvinyl chloride	Rats	17/44	38.6
Glass coverslip	Rats	1/50	

Experiments Still in Progress

Material	Animals	Malignant tumors produced	Animals still alive
Cellophane C	Rats	11	16
Pure polyethylene perforated	Rats	1	30
Pure polyethylene textile	Rats	1	31
Silastic	Rats	12	3
Teflon	Rats	4	15
Nylon	Rats	1[2]	21
Dacron	Rats	3	29
Dacron perforated	Rats	1	30
Polystyrene	Rats	2	22

Malignant tumors, adjacent to or actually surrounding the film, have been produced in rats or mice or both with the following plastics: (1) commercial cellophane film (regenerated cellulose), for convenience called by us Cellophane A; (2) the same cellophane film after it had been subjected to intensive extraction by methyl alcohol, called Cellophane B; (3) the same cellophane subjected first to alcohol and subsequently to benzene extraction, called Cellophane C; (4) polyethylene film, called Polyethylene A; (5) a pure polyethylene film, specially prepared for these experiments; (6) polyvinyl chloride film; (7) silastic, a silicone product; (8) Teflon film; (9) Dacron film; (10) polystyrene film; (11) with nylon film, so far only one tumor, a reticulum cell sarcoma surrounding the nylon, has appeared, 441 days after insertion. Successful transplantation of this tumor was made, producing reticulum cell sarcomas to the second generation. The remaining rats embedded with nylon are still under observation.[2]

To date the highest percentage of positive results (45.4%) was obtained by embedding cellophane B. Up to the present we have obtained a total of at least 126 primary tumors, including those from kidney wrappings, and many successful transplantations.

[1] This work was supported by a grant from the National Cancer Institute, U. S. Public Health Service.

[2] Since the above was written 3 more sarcomas have appeared at the site of embedding nylon film.

At least 23 more substances (mostly other polymers or variants on those mentioned before) are being tested for their carcinogenicity, but they have been embedded too recently for any report at this time.

In addition to these plastics, we have similarly embedded other materials as controls. Adequate controls are of the greatest interest and importance in such an investigation; and, at this point an addendum must be made to our previous report in 1952 (*2*). In that publication we stated that up to that time no tumors had appeared with the three substances embedded as controls; i.e., (a) the linters from which the Cellophane A. was manufactured, (b) sterile surgical cotton, and (c) chemically clean cover glasses. Recently, however, just before the completion of this last cover glass experiment, we obtained a solitary fibrosarcoma that surrounded a cover glass; this tumor appeared 659 days after the embedding, and was successfully transplanted. The cover glass was found broken into two fragments, but similar breaks were frequently found in the cover glasses that did not cause tumors. No certain explanation of this one exception among the controls can be made, but it is possible that some unknown carcinogen accidentally contaminated the cover glass at the time of the operation. In view of this single exception, a new series of control experiments is under way.

Subsequent to our publication, but independently, Druckrey (*3*) has induced sarcomas by similar procedures, using regenerated cellulose film and Polyamid film. He also produced peritoneal sarcomas by embedding platelets of cellophane in the peritoneal cavity of rats. Druckrey also observed that another rat, which had received cellophane orally, developed a lymphatic leukemia (lymphosarcoma) with malignant infiltration of the lymph nodes, liver, spleen, and lung. As this was the only such observation, we are speculating as to whether or not the leukemia was perhaps spontaneous.

The mechanism of production of these malignant sarcomas presents an interesting problem, and experiments are in progress to try to find an explanation. Types of tumors produced by embedding plastics are:

(1) *Malignant*: fibrosarcoma (the great majority are of this type), rhabdomyosarcoma, liposarcoma, osteogenic sarcoma, reticulum-cell sarcoma, lymphosarcoma, rhabdomyosarcoma (atypical), undifferentiated sarcoma, plasmocytoma, histiocytoma, myxoma, malignant mesenchymoma.

(2) *Nonmalignant*: 2 granulomas.

Table 1 shows the tumors obtained by embedding various plastics under the skin, the rodent used, the number of malignant tumors produced and the respective percentages.

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Volumetric Flasks and Microcell Filling Adapter for Use with the Perkin-Elmer Infrared Spectrophotometer[1]

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One of the problems encountered in quantitatively handling a very few milligrams of material in a solution of a concentration great enough to permit the preparation of good infrared absorption records has been solved to a great degree with the use of the apparatus illustrated in Figs. 1 and 2.

The 1-mm Perkin-Elmer microcell (Fig. 1) re-

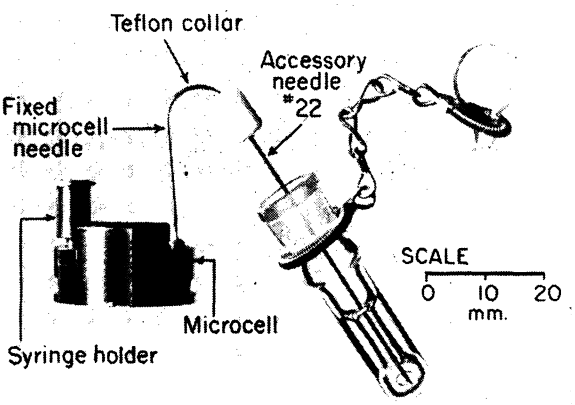

FIG. 1.

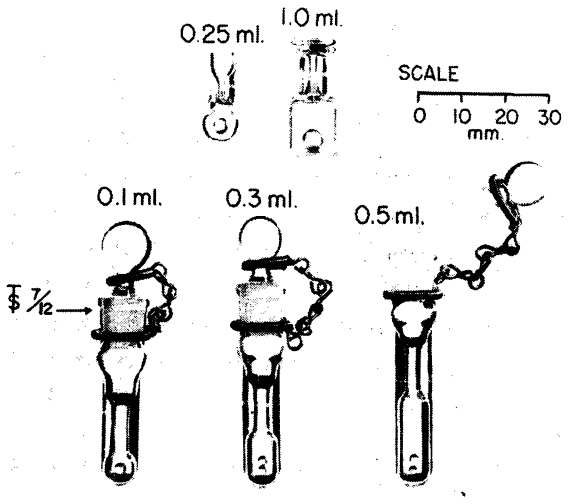

FIG. 2.

[1] Taken from a thesis submitted by O. D. Easterday as partial fulfillment for the degree Doctor of Philosophy. This work has been supported by grants from the Wm. S. Merrell Co., Cincinnati, and the American Cancer Society.

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