than 3 days had to be omitted because of lack of material, while those of longer duration again show a decrease in K/Cl. Since Jacques and Osterhout made all their determinations on cells exposed for 3 or more days to a solution containing 0.006 GM/l of K it will be seen that in those of our experiments which were substantially similar we both find a decrease in K/Cl. Unfortunately, they have not reported experiments comparable to those of mine in which I have found the ratio of K/Cl to have increased.‡

The data show an increase in the ratio of K/Cl when the reduction in the K content of sea water is slight and the experiment short, and a fall in that ratio with increase in either factor. The changes shown in Table I are not large, but they are consistent with all my previous findings, and suggest why other experimenters failed to observe the fact that decrease in the K content of sea water does under the right conditions lead to an increase in the proportion of K in the sap.

7035 P

Effects of Dinitrophenol on an Experimental Sarcoma of the White Rat.*

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Recent studies of the effect of dinitrophenol on metabolism[1] have prompted us to study its effect upon tumor growth. Since it is known that the metabolism of the cell of malignant neoplasms is more active than that of the normal cell, we were curious to learn whether or not dinitrophenol administered either by injection or mixed with the food would demonstrably affect the activity of the neoplastic cell. The tumor material utilized in this study is a fibrosarcoma which kills white rats in from 30 to 60 days. It was de-

‡ Jacques and Osterhout find practically no change in K/Cl at the time of their first observation (3 days), but the smoothing of the curves in their figures obscures this fact.

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1 Tainter, M. L., and Cutting, W. C., *J. Pharm. Exp. Therap.*, 1933, **48**, 410. (See for citation of literature.)

rived from a transplantable fibroma by intensive inbreeding. The fibroma, in turn, is a derivative from the mammary adenofibroma of the white rat. The sarcoma is non-metastatic but recurs locally for indefinite periods. It otherwise behaves like a malignant tumor of connective tissue origin.

Thirty white rats varying in age from 84 to 110 days were divided into 6 equal groups and implanted with a sarcoma from the same donor. Two groups were left untreated for controls. Two groups were injected twice daily, with 15 mg. per kg. body weight of alpha-dinitrophenol, the dose being increased when necessary to produce a maximum temperature rise of 2°C. One of these 2 groups was injected from the time of implantation and the other 14 days after the implant was made, or 2 days after active growth was apparent. One group was injected with 1% sodium bicarbonate, the solvent used in making the solution of dinitrophenol, and one group was fed stock diet to which had been added dinitrophenol in the concentration of 1:1000 (daily dose of dinitrophenol ingested about 43 mg. per kg.). The period of observation was between 3 and 4 weeks. The following results were obtained:

Gross Changes. As was to be expected, the average gain of body weight of all dinitrophenol-treated animals was retarded. The tumors of animals fed dinitrophenol grew with about the same speed as those of the controls. Animals injected with dinitrophenol from the time of implantation showed a slight retardation of growth of the tumor when compared to tumors in animals injected after the implant had begun to grow actively. On gross examination, neither group showed any remarkable changes not observed in the controls or animals injected with sodium bicarbonate.

Microscopic Changes. Cytologic appearances of tumors from animals injected with or fed dinitrophenol were not uniform. They differed from the controls and animals injected with sodium bicarbonate only in so far as most of them showed a marked vascular stasis, an apparent reduction in numbers of mitotic figures, an increase in active cellular destruction beneath the zone of growth, as expressed by pyknosis and karyolysis, and the presence of an increased number of leukocytes. The cellular destruction is not necessarily the direct result of the administration of dinitrophenol, but most likely depends upon the speeding up of surface growth which might be regarded as part of the general increase in cellular metabolism of the host as a whole. This contention of an increased speed of surface growth is strengthened by the presence of areas of increased vascularity in this zone.

The avidity of the cells of the growth zone may therefore be suspected of being increased when dinitrophenol is administered.

Conclusions. Dinitrophenol did not affect macroscopically the growth of an experimental sarcoma in rats, but microscopically there were evidences of increased vascularity and destructive cellular changes, whose significance remains undetermined.

7036 P

Effect of Agitation Upon Bacterial Growth.

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The course of population growth in a bacterial culture is known to depend upon many environmental factors, such as temperature, food supply, reactions, etc. We wish to suggest another factor which, from our studies, seems to be of importance—shaking.

The apparatus used in the shaking consists of a motor-driven shaft to which clamps can be attached. The motion of the shaft is reciprocal. The clamps are used for securing culture flasks to the machine. We have generally used about 275 shakes per minute. The extreme agitation is attained in flasks having an up and down excursion of 2.5 inches. For the minimum shaking, the center of mass of the medium was placed at the center of motion of the shaft, thus obtaining little more than a rippling of the surface of the medium.

Flasks inoculated with similar amounts of *E. coli* culture have been studied. Plates were prepared at intervals; smears at the time plates were made. Control flasks unshaken were also studied.

The results indicated in the accompanying figure: (a) The agitated culture reaches a higher population level compared to the unagitated. (b) The growth rate is virtually the same (generation time agitated 26 minutes, unagitated 30 minutes). (c) Log phase lengthened (in some instances 100% longer). (d) Cell size greatest at beginning of log phase, least at end. (e) Cell size 1/3 less in agitated culture.

The observation was also made that (a) Agitated cells (less in size) much more motile than the non-agitated cells. This appeared to be a Brownian movement. (b) Degree of agitation not a factor in phenomenon.