cium level of operated animals was much more sensitive than that of normal animals to injected parathyroid hormone.

The figures for normal animals show that, as might be expected, increasing age led to lowered bone citrogenase activity. Because the fall in bone citrogenase after parathyroidectomy appears to develop slowly it is probable that the fall in serum calcium produced immediately after parathyroidectomy is not due to change in bone citrogenase. Also, the failure to increase the bone citrogenase by parathyroid hormone injection may have been due to the insufficient time allowed for this effect to develop.

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The Effect of Malonate on *Salmonella typhimurium* Infection in Mice[1]

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The effect of changes in the tricarboxylic acid cycle on *Salmonella typhimurium* infections in mice has been investigated[2] in order to determine the extent to which host metabolism influences response to this pathogen. In a series of experiments over a period of nearly 3 years (*1*), it has been established that mice exposed to the hypoxia of altitude are more susceptible to Salmonellosis than normal control mice. This greater susceptibility, however, is not accompanied by any experimentally demonstrable change in the mechanisms of defense against infectious diseases. A tentative explanation for these observations suggests that the stress of altitude results in some alteration in metabolism which in turn makes the mouse succumb more quickly to the infection. In the absence of any experimental evidence with which to substantiate the hypothesis, the present work was undertaken.

The particular procedure adopted was based on essentially unrelated reports in the literature. Mice subjected to the hypoxia of a simulated high altitude synthesize less influenza A virus in the lungs than control mice at normal pressures (*2*). Similarly, mice injected with sublethal amounts of sodium fluoroacetate synthesize less influenza A virus in the lungs (*3*) and less poliomyelitis virus in the central nervous system (*4*) than normal control mice. This poison, which probably blocks aconitase or isocitric dehydrogenase (*5*), results, *in vivo,* in an accumulation of citric acid in lungs (*3*) and in other organs (*6*). Another metabolic inhibitor, sodium malonate, which blocks succinic dehydrogenase (*7*) and possibly other enzymes (*8*), also produces an accumulation *in vivo* of citric acid in sublethal amounts (*9*). Since sodium malonate is known to be metabolized (*10*) and excreted (*9*) within a comparatively short time, repeated injections are required in order to maintain the block of the citric acid cycle (*9*).

Female mice of the CF-1 strain, weighing 20–25 g, were infected intraperitoneally with 0.5 ml of a saline suspension of *S. typhimurium* containing approximately 250,000 cells. Normal control mice receiving this number of bacteria suffer the first casualty on the third day, except in rare cases, and most of the animals succumb after 6 days. Twenty of these mice were given intraperitoneal injections of 0.5 ml saline at hourly intervals, starting immediately after the bacteria were administered and continuing for a total of 8 injections. The survival data of these animals are shown in Table 1, column 3. Twenty infected mice were treated in similar manner except that they were injected with 20 mg sodium malonate dissolved in 0.5 ml of saline for a total of 8 injections with the results shown in Table 1, column 2. The survival data of 15 mice not infected but given the 8 injections of malonate are given in Table 1, column 4.

It is apparent that mice infected with *S. typhimurium* die much sooner than control mice when their tricarboxylic acid cycle is blocked by sublethal injections of malonate. The malonate alone is not lethal but when it is given to infected mice, many die within a period of 8 hr, long before the control mice show

TABLE 1

NUMBER OF MICE SURVIVING EXPERIMENTAL TREATMENT AT TIMES DESIGNATED

Time in hours from beginning of experiment	Mice inoculated with *S. typhimurium* and injected at intervals of 1 hr with:		Mice not infected but injected at intervals of 1 hr with
	8 × 20 mg malonate in 0.5 ml saline	8 × 0.5 ml saline	8 × 20 mg malonate in 0.5 ml saline
0	20	20	15
4	20	20	15
5	18	20	15
6	15	20	15
7	11	20	15
8	8	20	15
24	1	20	15
48	0	19	15
72		5	15

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any signs of illness. This synergism between bacteria and metabolic inhibitor has been confirmed in several duplicate experiments not only with the same pathogen and inhibitor but with other pathogens and poisons as well. These results have broad implications for the phenomenon of parasitism and should be investigated from a variety of approaches. More detailed reports are in press.

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Identification of Glycogen in Whole Bacterial Cells by Infrared Spectrophotometry

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A recent report of infrared spectra of intact bacterial cells indicated that some of the bands could be interpreted as protein, nucleic acid, and polysaccharide absorptions (*1*). Subsequent work has shown, in addition, that a glucan of the glycogen-starch type can be identified in spectra of whole cells. This glucan was isolated and proven to be glycogen.

Absorption bands at 8.7, 9.25, and 9.75 μ were observed in the spectra of dry films of enteric bacteria grown on nutrient agar with added carbohydrate. When the growth medium lacked the carbohydrate, only the 9.25-μ band was observed in this spectral region (Fig. 1). The effect of the carbohydrate on the bacterial spectrum was more pronounced when cultures were incubated at 15–20° C rather than at 37° C. The additional absorption bands at 8.7 and 9.75 μ, when weak, appeared only as inflections on the sides of the 9.25-μ band, whereas, when strong, they were accompanied by a deepening of the 9.25-μ band and the appearance of new absorptions at 10.75, 11.8, 13.2, and 14.2 μ.

In an attempt to find the origin of this group of absorption bands, cells of *Aerobacter aerogenes* grown at 15–20° C for 2 days on nutrient agar (Difco) with 1% glucose were subjected to chemical fractionation; infrared spectrophotometry was used to follow the course of the procedure (Fig. 1). Since aqueous extraction failed to remove the characteristic bands from the bacterial spectrum, the cells were disintegrated by sonic vibrations (10 kc). After the debris was removed by centrifugation, infrared spectra showed the desired material in the opalescent supernatant. It was found to be precipitable by 1 volume of 95% ethanol, and the spectra revealed that successive reprecipitations caused progressive attenuation of the 6.05- and 6.45-μ bands which can be attributed primarily to protein. The last traces of protein were removed by shaking with chloroform and isoamyl alcohol. After this treatment the spectrum had no band at 6.45 μ and only a weak band at 6.05 μ, the latter probably due to residual water. The spectrum of the final product showed the characteristic bands at 8.7, 9.25, 9.75, 10.75, 11.8, 13.2, and 14.2 μ, and it was identical with the spectrum of a commercial glycogen preparation. The

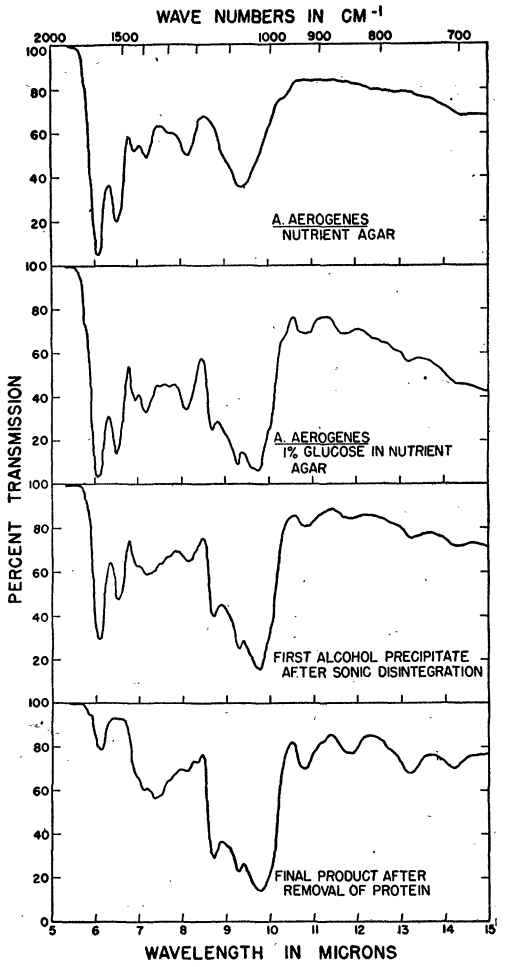

FIG. 1. Infrared spectra showing presence of glycogen in glucose-grown cells.

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