Brain Phosphate in Fasting Rats.* (29739)

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It is, of course, no more appropriate to consider the brain "immune" to starvation (1) than any other organ, but there appears to be wide agreement that it is relatively resistant to the effects of acute or chronic undernutrition. Slight loss of brain weight has been reported(2), but this is probably not an accurate measure of the loss of solid constituents, because there is ample evidence (1) that the brain becomes edematous during prolonged fasting.

In the present investigation, 140 adult male Long-Evans rats were studied. Groups of 25-30 animals were fasted respectively 3 days, 6 days, and 9 days, with free access to water, and a control group was offered food as well as water *ad lib*. The rats were maintained in individual metabolic cages to prevent coprophagia and cannibalism. Twenty-four hours prior to sacrifice, they were injected i.p. with 2.0 μc per gram body weight of $P^{32}O_4$ in water. The 24-hour interval, too brief for equilibration, was chosen arbitrarily to make comparison possible between phosphate uptake at various stages of fasting. The animals were sacrificed by guillotine, and samples of blood, anterior tibial muscle, liver and brain (mostly cortex) were collected and prepared for determination of radioactivity. Radioactivity was measured with a Scott-type Geiger-Müller counter, with corrections for decay, coincidence and self-absorption.

A modification of the method of Fiske and Subbarow(3) was used to determine total P (10 rats) and phospholipid P (9 rats) in animals fasted 9 days, and in a control, non-fasted group of 8 rats. Wet and ashed weights of the whole brains of these animals were recorded. Phosphorus determinations on lipid portions were performed, after fractionation, with a modification of the method of Schneider(4).

TABLE I. Effects of Fasting on Rats.

Days fasted	Brain P^{32} uptake (%)*	Body wt loss (%)
0	.101	0
3	.091	10
6	.077	21
9	.069	34

* Percentages represent ratios between uptake of radioactivity per g of brain, and injected radioactivity per g of total body wt.

Table I shows a 34% loss in body weight, and also a progressive decrease in the radiophosphate uptake by the rat brain during the 24-hour period which ended on the 9th day of fasting. Uptake on the 9th day was 33% lower than in the control ($p<0.01$).

The chemical studies showed a remarkably similar decrease in total brain phosphorus. After 9 days' fasting, total P fell 35%, from 190 μmoles/g wet weight to 123 μmoles/g wet weight ($p=0.01$). Lipid phosphorus levels after 9 days of fasting were 27% below control levels of 66 μmoles/g wet weight ($p<0.01$). The ashed weights of whole brains of fasted rats averaged 11.5% less than those of non-fasted rats ($p=0.01$). Since there was no difference in wet weights, this may be interpreted as replacement of brain solids by edema fluid(2).

In Fig. 1 uptakes of radiophosphate by the 4 tissues studied are contrasted. The uptake into liver increased significantly during the first 3 days of fasting ($p=0.01$), thereafter declining to 55% below control levels by the 9th day ($p=0.001$). Muscle uptake decreased slightly between the first and 9th day of fasting ($p=0.05$). Radiophosphate circulating in the blood did not change significantly.

In contrast, measurements in the same animals of "bound" phosphate (phosphate which did not pass through a cellophane dialysis membrane in 2 hours of dialysis at room temperature(5)), did not show statistically

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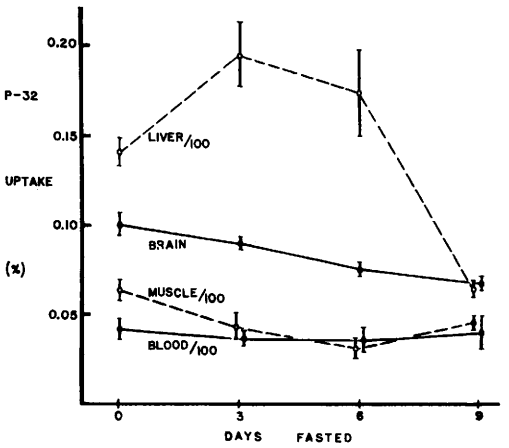

FIG. 1. 24-Hr radiophosphate uptake after I.P. injection in fasting and non-fasting rats. Each point is average of 25-30 experimental determinations. Vertical bars are standard deviations. Percentages express ratios between uptake of radioactivity per gram of tissue, and injected radioactivity per gram total body weight. Values for liver, muscle and blood were divided by 100 so they could be plotted on the same scale as brain.

significant changes, though the terminal values of this binding were somewhat higher than control values.

These results are generally similar to those of others on phosphates and phospholipids in liver, muscle and blood(6,7,8,9). The change in brain phosphate uptake is a new observation, which may be correlated with the known decrease in blood glucose during fasting in the rat(10). Also, since phosphate is an essential component of the principal energy systems of the brain, the decreased uptake may reflect an absolute decrease in metabolic activity, related directly to loss of reactive tissue mass. This direct relation is supported by the similarity between the decrease of uptake of labelled phosphate and the decrease of total phosphate in the brain (33% *vs* 35%).

Summary. In the brains of fasted rats, the 24-hour uptake of radiophosphate ($P^{32}O_4$), the total phosphate content, and the phospholipid phosphate content were all decreased. In the liver, radiophosphate uptake increased for 3 days, then decreased to less than control values. Muscle uptake decreased slightly.

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