predicated that ricketic serum is undersaturated with respect to $CaHPO_4$; normal serum should be slightly undersaturated with respect to this substance.

This theory was tested by shaking blood sera for one hour at 38° with crystalline $CaHPO_4$. As a result of the equilibration, the phosphorus increased in all cases; in some cases both calcium and phosphorus increased. In every case equilibration produced an increase in the Ca x P product and in the [Ca] x [HPO_4''] product. In the sera as drawn, the Ca x P products ranged from 35 to 85, and the [Ca] x [HPO_4''] products ranged from 2.4×10^{-6} to 5.7×10^{-6}. The final Ca x P products ranged from 74 to 88; the final [Ca] x [HPO_4''] products ranged from 5.3×10^{-6} to 6.5×10^{-6}.

The sera used were obtained from a young calf, young lambs and from human beings. All of them were found to be undersaturated with respect to $CaHPO_4$. In inorganic solutions of the same ionic strength, [Ca^{++}] x [HPO_4''] had been found to be 3.4×10^{-6} at equilibrium. The equilibrium values of [Ca]x[HPO_4''] in sera are greater than this, as was expected since, in serum, [Ca] is greater than [Ca^{++}]. The values obtained may therefore be utilized in calculating the amount of "bound" calcium and ionized calcium in serum.

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Irreversible Character of the Late Changes after Hepatectomy.

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We have endeavored to learn whether rabbits manifesting the symptoms characteristic of the advanced stage of liver insufficiency[1,2] can be clinically improved by the circulation of their blood through the livers of healthy animals or by cross transfusion with normal rabbits.

"Liver transfusion." In an initial series of 14 experiments, rabbits, hepatectomized under ether and with cannulae placed in the left carotid artery and left jugular vein, were given sufficient glucose to maintain the blood sugar level well above normal. Fourteen to 24 hours later, when the characteristic signs of advanced hepatic insufficiency in the rabbit[1,2] had appeared, the portal vein and vena

[1] Drury, D. R., *J. Exp. Med.*, 1929, xlix, 759.

[2] McMaster, Philip D., and Drury, D. R., *J. Exp. Med.*, 1929, xlix, 745.

cava connecting with the liver of a healthy animal were rapidly cannulated, the hepatic artery was tied and the organ was removed. It was submerged at once in a bath of paraffin oil at 40° C., and connected with the circulation of the liverless animal by means of the cannulae already present in the carotid artery and jugular vein of the latter. In this way the circulating blood of the liverless animal was passed for as long as an hour through the freshly removed liver of the healthy rabbit.

Of 14 experiments 4 were carried to completion without lapses of technique which might render the findings questionable. In none of the 14 did clinical improvement of the liverless animals take place though the "transfused" liver was actively functioning as shown by a copious formation of bile.

Cross transfusions. The effect was next studied of cross transfusions between normal rabbits and liverless ones showing the signs of advanced hepatic insufficiency. Of 15 such experiments 5 were completed without technical lapses. In 2 of these latter the blood, leaving by cannula in the proximal end of a carotid artery of each animal, entered the circulation of the other one through a cannula placed in the distal end of its carotid. In the 3 remaining instances, cross transfusion was performed from the carotid artery of the one animal to the jugular vein of the other. The rabbits receiving the blood from hepatectomized individuals in these ways over periods up to an hour and a half showed no ill effects; but, on the other hand, the symptoms of liver deprivation were not ameliorated nor death in consequence of it deferred. This held true in all 15 cases.

From the findings here reported, the late changes after liver deprivation, those leading to death, would appear to be irreversible.

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Glucose Requirement of Hepatectomized Rabbits and Its Relation to Lactic Acid Production.

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We have previously reported[1] on the minimal glucose requirements of the hepatectomized rabbit during the first 6 to 8 hours after operation. During that period, a constant intravenous injec-

[1] Drury, D. R., and McMaster, P. D., *J. Exp. Med.*, 1929, xlix, 765.