Following a very favorable diet (for example, liver) we note a *storage* of potential material which, in the next week or two of unfavorable diet, will be responsible for the production of a considerable excess of hemoglobin. We may speak of this as a carry over due to storage of parent substances capable of manufacture into hemoglobin. It is probable from our feeding experiments that this substance is stored in the liver and kidney in considerable quantity. On a normal diet dogs always store in the body a considerable reserve of material which can be built into hemoglobin when the diet is changed to one unfavorable to hemoglobin production.

The importance of plasma volume determinations is evident from an examination of the tables and often an apparent increase in hemoglobin value is explained by the blood plasma volume decrease rather than by actual hemoglobin increase. Change in plasma volume with change of body weight due to favorable diet is illustrated. The complete experimental data will be published in the near future.

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The effect of potassium on the metabolism of surviving muscle tissue.

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The following experiments were undertaken in order to determine whether the pronounced effect of potassium on the contractile process in skeletal and cardiac muscle is associated with changes of metabolism, as indicated by variations in the rate of acid production.

Isolated frog tissues were used in all the experiments and their "normal" rate of acid production was determined in Ringer's solution before treating them with potassium. The Ringer's

* Introduced by Wayne J. Atwell.

solution consisted of a mixture of the three chlorides, in the usual concentration for cold-blooded tissues, and the potassium effect was obtained by immersing the muscle in an isotonic solution of potassium chloride. Precaution was taken to have the Ringer's and potassium chloride solutions of the same pH and buffer capacity. The experiments were carried out at various room temperatures, but never did the temperature vary significantly during any one experiment. The experiments fall into three classes, as follows:

1. *The effect of potassium on the total acid production of skeletal muscle.* Sartorius muscles were used in these experiments and their rate of total acid production was measured by the indicator method of Haas,[1] using phenol red as indicator. Determinations were made of the time, in seconds, required by a muscle to produce sufficient acid to cause an increase in the acidity of the solution it was in from pH 7.381 to pH 7.168. Each determination was made with the muscle immersed in 2.5 cc. of solution (Ringer or KCl) in a hard-glass test tube of 3 cc. capacity, stoppered with a paraffined cork. At least two determinations were made of the rate of acid production in Ringer solution, in order to establish the "normal", before treating the muscle with potassium; it was then immersed, without any delay, in isotonic potassium chloride solution, previously adjusted to the same pH and buffer capacity as the Ringer.

Twenty-six experiments of this kind were performed and they all concurred in showing that the rate of acid production is increased under the influence of potassium. The average increase for the entire series was approximately 200 per cent. This increase occurs immediately, reaching its maximum within 5 to 10 minutes and then subsides until the rate is again "normal" within 40 to 60 minutes.

2. *The effect of potassium on the carbon dioxide production of skeletal muscle.* These experiments were undertaken in order to determine to what extent carbon dioxide might be responsible for the increased acid production described in the preceding section. Carbon dioxide production was measured by a modification of the Osterhout technique, which has been previously described.[2] In order that the carbon dioxide production would be

[1] Haas, *Science*, N. S., 1916, xliv, 105.

[2] Griffith, *Am. J. Physiol.*, 1923, lxv, 15.

great enough for rapid determination by means of this method, both hind legs of a frog were used in each experiment, rather than a single muscle. This might be expected to lead to differences in regard to the relative magnitude and time relations of the effect in these, as compared with the preceding experiments on account of the slower rate of penetration of the potassium ion into large, as compared with small, (sartorius) muscles. With the exception of slight differences in magnitude and duration which probably have their origin in this difference in method, the results of this series of experiments (12 experiments in all) show a fair correspondence with those just described. Thus, the carbon dioxide production was increased in rate about 150 per cent; the maximum was attained within 20 to 30 minutes; and the rate had not returned to "normal" until the end of 1½ to 2 hours.

These experiments make it probable, therefore, that the increased acid production, described in the preceding section, consists in large part, if not entirely, of carbon dioxide.

3. *The effect of potassium on the total acid production of cardiac muscle.* The marked difference in the effect of potassium on the contractile process in skeletal and cardiac muscle makes a comparison of its effect on their metabolism of interest.

Frog hearts were used in these experiments and their rate of acid production was determined by the method described in Section I. In many of the experiments the entire heart, including the sinus, was used and such hearts were beating regularly until they were treated with potassium. This might seem to invalidate the comparison of the effect of potassium on this tissue with its effect on quiescent skeletal muscle. In other experiments, therefore, the sinus was cut off at the time of removal of the heart from the body and these hearts were observed not to have resumed beating during the preliminary determinations of their "normal" rate of acid production in Ringer. This factor appeared not to influence the results, for in all cases the rate of acid production progressively diminished after immersion in the potassium chloride solution. This conclusion is based on the results of 18 experiments with hearts that were quiescent or were beating at rates varying from 24 to 64 per minute and in which the potassium effect was produced at times varying from 20 minutes to 7 hours during the survival period.

In order to evaluate these results it became necessary to establish the "normal" course of survival acid production for heart muscle during such periods as were used in these experiments. This was found to diminish in a manner similar to that found by Fletcher[3] for the survival carbon dioxide production of skeletal muscle. And, by comparison with this "normal" decrease, it became apparent that potassium causes an immediate and pronounced drop in the rate of acid production to a magnitude approximately 75 per cent below what might have been expected if the tissue had remained in Ringer.

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Changes in the blood sugar and blood gases during exercise.

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It has been found by Scott and Hastings[1] that exercise causes a slight decrease in blood sugar and an increase in the oxygen content of the blood of dogs when they are made to work on an electrically driven horizontal treadmill at the rate of five miles an hour. We have made a study of the influence of exercise on the blood sugar and blood gases of several cats and one dog. The animals were exercised in a circular treadmill with a tread 5.75 meters long. Blood was collected under paraffin oil from an incision in an ear vein. The gases were analyzed immediately by Van Slyke's method of determining[2] the oxygen and carbon dioxide in one cubic centimeter of blood. Sugar was determined by the method of Hagedorn and Jensen.[3]

Ten cats were studied in which the blood sugar alone was determined. With five other cats and the dog the sugar, oxygen

[3] Fletcher, *J. Physiol.*, 1898, xxiii, 10.

[1] Scott, E. L., and Hastings, A. B., PROC. SOC. EXP. BIOL. AND MED., 1920, xvii, 120.

[2] Van Slyke, D. D., and Stadie, W. C., *J. Biol. Chem.*, 1921, xlix, 1.

[3] Hagedorn, H. C., and Jensen, B. N., *Biochem. Z.*, 1923, cxxxv, 46.