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.

281 (2513)

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.

and carbon dioxide of the blood were determined. In the latter set, two or three experiments were performed with each animal. In all but one case the cats were exercised by driving the treadmill by hand. The animals usually worked from ten to thirty minutes travelling from 500 to 1500 meters. In every instance where this was done, the blood sugar invariably increased more than 100 per cent, occasionally as much as 400 per cent. In these experiments the carbon dioxide was lowered markedly, commonly to twelve volumes per cent and occasionally as low as eight volumes per cent. This was apparently caused by the very rapid breathing accompanying the strenuous exercise. The oxygen was at first increased and then later decreased in some experiments. In other experiments the oxygen was decreased without a previous period of increase.

The sugar returned to normal or nearly so after four or five hours. The carbon dioxide returned after one or two hours and then frequently rose above normal. The oxygen remained below normal for a variable period of a few hours.

Convulsions occurred occasionally in some experiments. The blood sugar at this time was always maximal or nearly so. The carbon dioxide, on the other hand, was usually quite low. However a carbon dioxide as low as six volumes per cent has occurred unaccompanied by convulsions.

In contrast with the preceding results of forced exercise, is the following result with a dog that was allowed to run at its own pace in the treadmill. As a result of travelling 28 kilometers in six hours, the blood sugar gradually fell from 131 mg. to 113 mg. per 100 cc.; the carbon dioxide was lowered from 39.64 volumes per cent to 36.55 volumes per cent and the oxygen was at first raised from 22.64 volumes per cent to 23.65 volumes per cent and then fell to 21.56 volumes per cent.

When, however, we worked the dog in the mill turned by hand at a pace which she did not happen to like, she resisted. Although she was made to travel only 575 meters in 17 minutes, the blood sugar increased from 119 mg. to 131 mg. per 100 cc.; the carbon dioxide was lowered from 40.71 volumes to 24.71 volumes per cent and the oxygen increase was very slight (22.68 volumes to 22.96 volumes per cent). It appeared from this experiment that the reaction of the animal was an important factor in determining whether an increase in blood sugar occurred. We, therefore,

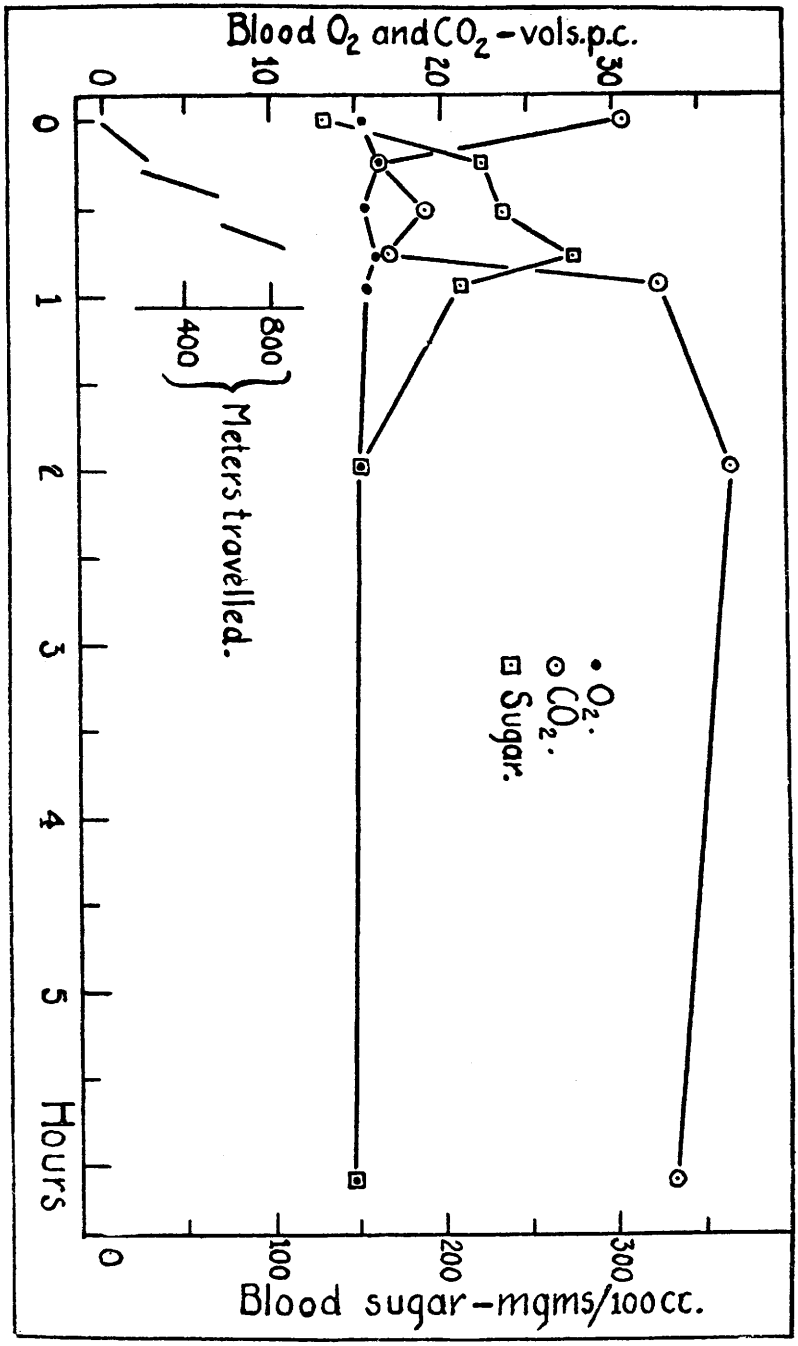
Blood O_2 and CO_2 – vols. p.c.
0
10
20
30
0
1
2
3
4
5
Hours
400
800
Meters travelled.
• O_2.
⊙ CO_2.
⊡ Sugar.
0
100
200
300
Blood sugar – mgms/100 cc.

FIG. 1.

trained a cat to run in the treadmill unassisted. This cat had previously shown a great increase in blood sugar and a marked reduction in carbon dioxide when the exercise was forced, *i. e.*, in the hand-driven treadmill (Fig. 1). When running in the treadmill of its own accord, this cat travelled 6090 meters in 160 minutes. During that time the blood sugar increased somewhat, but

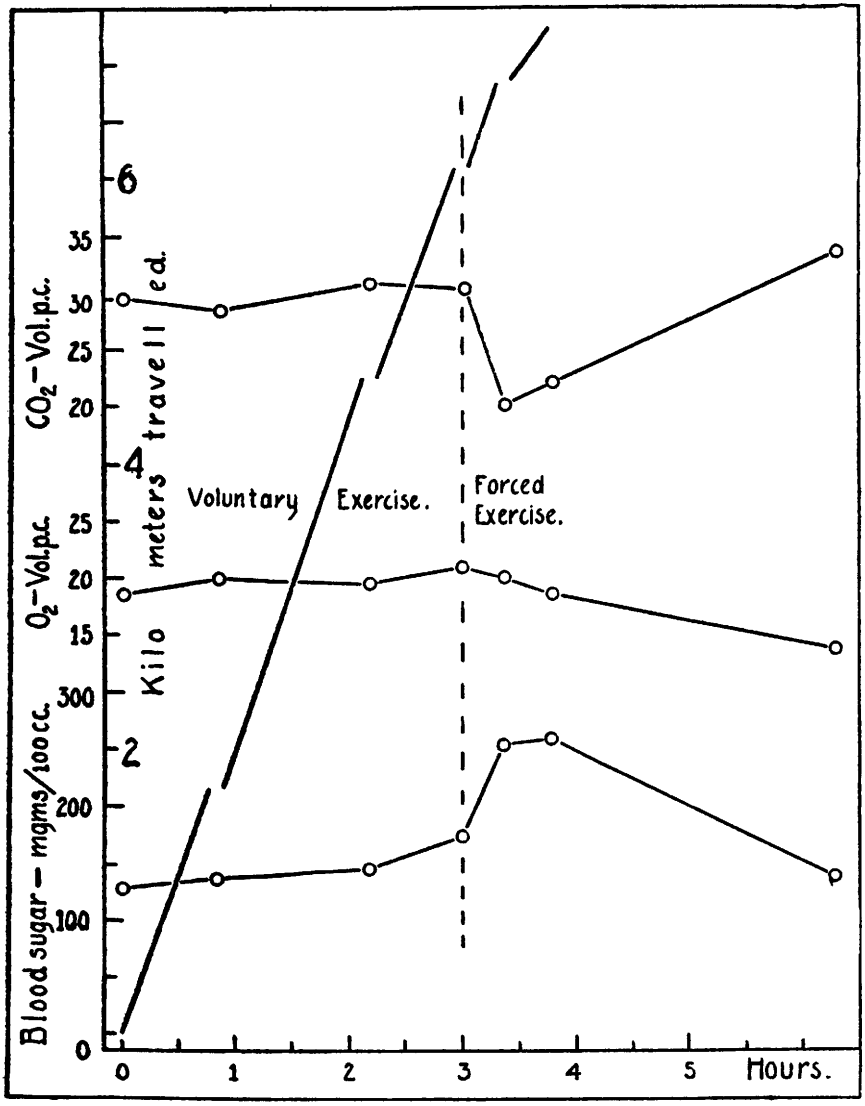

FIG. 2.

nothing like the increase in forced exercise; the carbon dioxide after a slight decrease, increased slightly and the oxygen increased (Fig. 2). The treadmill was then turned by hand. The cat, although travelling no faster than before, resisted by trying to cling and jump part of the time. Although it was made to travel only 960 meters in this manner, the blood sugar increased markedly; the carbon dioxide was much diminished, and the oxygen fell off slightly.

These experiments indicated that the development of aggressiveness and a fighting reaction is important in producing an increase in blood sugar. The carbon dioxide decrease is accounted for by the excessive ventilation (shown by the very great increase in the rate of respiration) accompanying such forced exercise.

282 (2514)

A new method for the colorimetric determination of small concentrations of thymol.

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In order to evaluate the thymol content of sodium-fluoride, thymol mixtures used for the preservation of blood samples, the following simple method was devised.

Sulphanilic acid is diazotized and then coupled with thymol in alkaline solution. A reddish brown color stable for at least 50 minutes is obtained. The only alkali that gives satisfactory results is $NaHCO_3$.

METHOD (outline). 3 cc. of a 0.6 per cent sulphanilic acid solution (contains theory HCl necessary to form sulphanilic acid hydrochloride) and 0.5 cc. of 2.0 per cent HCl are pipetted into a sugar tube (Myers-Benedict). 0.5 cc. of a 1.5 per cent aqueous solution of $NaNO_2$ are then added and after one minute 1 to 5

* Introduced by H. U. Williams.