blood was .81 ± .05. Eight respiratory quotients obtained from the air during rest yielded an average of .82 ± .04. Sixteen air samples collected from exercising dogs gave an average of .82 ± .07.

The respiratory quotient of the exercising muscle *in situ* is not unity. This indicates that not only carbohydrate foodstuffs but also non-carbohydrate are used in muscular exercise.

3280

Effect of Insulin and of Muscular Exercise on Protein Metabolism.

WILLIAM H. CHAMBERS* AND ADOLPH T. MILHORAT.

From the Department of Physiology, Cornell University Medical College, New York City.

The total urinary nitrogen was determined in hourly periods on normal fasting female dogs weighing 6 to 20 kilos. The urine was collected by catheter and the bladder thoroughly rinsed each time. After 3 preliminary control hours, insulin (usually 5 units per kilo of body weight) was injected subcutaneously and the urine collected for 3 or 4 periods until sugar was given to the animal to relieve the hypoglycemic convulsions.

The changes in protein metabolism after the insulin depended upon the nutritive condition of the animal. After short fasting periods of 1 to 5 days insulin increased the nitrogen excretion. In a typical case, on the second day of fast, the increase was from an average of 99 mg. per hour during the preliminary hours to 137 mg. after insulin. With a longer fasting period of 7 to 14 days, insulin produced no effect, for example 101 mg. per hour before and 100 mg. after the injection. When carbohydrate (50 to 100 gm. of sucrose) was administered every 3 or 4 days to an otherwise fasting animal, the injection of insulin produced the same increase in nitrogen excretion on the 16th as on the 2nd day of fast. Similar results were obtained on a dog in which muscular movement was prevented by amytal anesthesia.

Two fasting dogs were run daily on a treadmill to observe the effect on protein metabolism of decreasing the body carbohydrate through muscular exercise. After 4 hourly preliminary control periods the dogs were exercised for 3 half hour periods and obser-

* Fellow in Medicine, National Research Council, 1924-26.

vations continued for 2 hourly post-work controls. The 1st day of fasting there was no increase in excreted nitrogen during exercise. The 2nd day, there was some increase during exercise, a maximum increase on the 4th day, and, less each succeeding day, until there was no increase on the 8th, 9th and 10th days. The increased nitrogen, during the working period, continued during the post-work hours, *i. e.*, on the 4th day the preliminary period averaged 128 mg. of urinary nitrogen per hour, the exercise period 180 mg., and the post-work period 180 mg. After giving 500 grams of sucrose on the 11th day of fasting, exercise on the 12th day produced no increase in nitrogen metabolism.

Our insulin results indicate that the increased nitrogen excretion, after insulin, is correlated with the presence of carbohydrate reserves in the body rather than with a calling forth of reserve protein to counteract the insulin after the depletion of the carbohydrate stores. However, the exercise experiments show that muscular work can be accomplished without an increase in nitrogen excretion if sufficient carbohydrate is available. This is also the case after about 8 days of fasting and exercise. Exercise is accompanied by an increased protein metabolism during the early part of the fast.

3281

Experiments on Activation of Cholesterol Derivatives and Allied Sterols by Ultra-violet Irradiation.

ALFRED F. HESS AND A. WINDAUS.

From the Department of Pathology, College of Physicians and Surgeons, Columbia University, and the Chemical Laboratory, University of Goettingen, Germany.

It has been shown repeatedly that cholesterol can be rendered antirachitic by subjection to ultra-violet rays. In a previous paper[1] it has been pointed out that "the saturated reduction products of cholesterol and phytosterol—dihydrocholesterol and dihydrophytosterol—were not activated by irradiation and did not acquire antirachitic properties." It was further shown that "cholesterol acetate, an unsaturated ester of cholesterol, developed antirachitic potency as the result of irradiation."[2] These results were "regarded as additional evidence that the double bond plays an essential rôle in activation." It has recently been shown by Rosenheim and Webster that in addition to the unsaturated carbon linkage of the