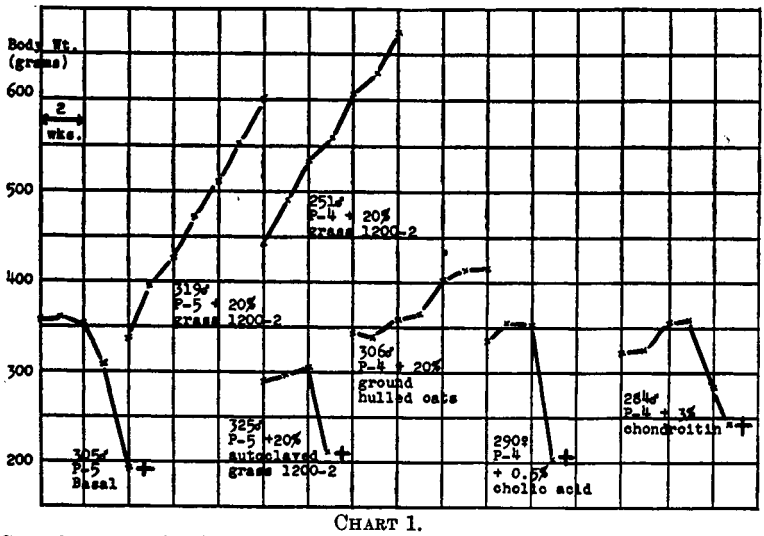

CHART 1.

Growth curves of guinea pigs fed rations P-4 and P-5 plus various supplements. Pigs 284, 290, and 305 showed severe stomach ulcers upon autopsy.

such as P-4 and P-5. The growth-promoting factor is undoubtedly the grass juice factor and is supplied from properly prepared young grass. In this connection it is interesting to refer to a paper by Wulzen and Bahrs[6] which was called to our attention by Dr. Ira Manville. These workers describe a condition in guinea pigs very similar to the deficiency of the grass juice factor which can be prevented by fresh kale or fresh alfalfa.

The second factor, which may be called the stomach ulcer factor, may not be supplied in adequate amounts by 20% of grass. It is apparently present in fair amounts in grains since guinea pigs have been kept on ration P-5 plus 20% ground hulled oats for 15 weeks with no indication of stomach ulcers.

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Effect of Gelatine on Muscular Fatigue.

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It has been reported by Boothby[1] that the onset of muscular

[6] Wulzen, R., and Bahrs, A. M., *Physiol. Zool.*, 1936, **9**, 508.

[1] Boothby, W. M., *Proc. Mayo Clin. Staff Meetings*, 1934, **9**, 600.

fatigue can be delayed by the addition of a considerable amount of glycine to the diet of the normal individual. He has further shown that in cases of myasthenia gravis and similar diseases the feeding of glycine tends to restore the wasted muscle tissue, thus indicating an effect upon the physiological state of these tissues. Wilder[2] believed his ability to play tennis increased after 2 weeks on a glycine diet. The possible explanation of these reactions is to be found in the creatinogenic action of glycine and the storage of at least part of this product in the muscles.[3] This is quite in accord with the current concept of the chemistry of muscular contraction wherein creatine in its combination with phosphoric acid plays an important rôle. The concept of storage is confirmed by the work of Rose, Ellis, and Helming,[4] who found a male subject on a creatine diet could store this substance. This was not evident in the case of a female subject.

Unfortunately, Boothby found that normal subjects were unable to take large amounts of glycine without some discomfort.[1] It seemed of interest, therefore, to determine if a food rich in glycine would also increase the amount of work a trained subject was capable of doing before fatigue set in. Among the dietary possibilities, perhaps the most outstanding is gelatine, which contains about 25% glycine, is easily digested, and is readily available as a food substance.

To the authors' knowledge, none of the above papers, concerned with muscular fatigue and glycine, reported quantitative studies on the work output of their subjects. It was felt, therefore, that it was important that the amount of work done be measured as accurately as possible, both during a training period and during a period when gelatine was added to the normal diet. For this purpose a bicycle ergometer of special design was used. The essential part is a small self-exciting 110 volt A. C. generator driven by the rear wheel of a stationary bicycle. The load on this generator depends upon a series of lamps in parallel and the output is read on a watt-meter.* Thus, by observing the output in watts and timing the duration of work, the total energy developed during the exercise period can be calculated.

Ten subjects, 6 men and 4 women, were trained on the ergometer

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2 Wilder, R. M., *Proc. Staff Meetings Mayo Cl.*, 1934, **9**, 608.

3 Tripoli, C. J., and Beard, H. H., *Southern Med. J.*, 1938, **31**, 662.

4 Rose, W. C., Ellis, R. H., and Helming, O. C., *J. Biol. Chem.*, 1928, **77**, 171.

* The writers wish to acknowledge with thanks the courtesy of the General Electric Company in supplying the necessary special meter and generator.

until the maximal output of work before fatigue set in was as constant as could be expected under the experimental conditions. After a satisfactory training period, the end of which was determined by the constancy of the daily work, the subjects were placed on a gelatine† diet. Three of the women subjects took 45 g per day, the fourth took 67.5 g. The men were all given 60 g. It is realized that these amounts are, to a degree, arbitrary but do approximate in the case of the men a dose of 15 g of glycine which is within the range used by Adams, *et al.*, for normal subjects.[5] It was

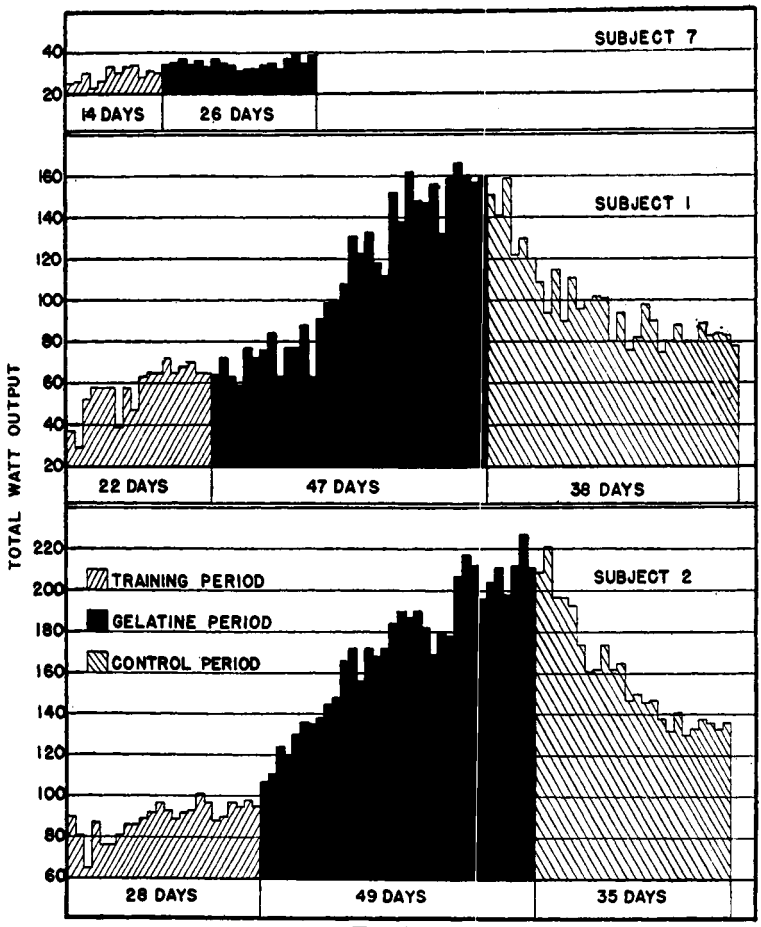

FIG. 1.

† The writers wish to thank the Knox Gelatine Laboratories for their cooperation and the supply of gelatine.

[5] Adams, M., Power, M. H., and Boothby, W. M., *Am. J. Physiol.*, 1935, **111**, 596.

found that the most convenient way of administering these large amounts of gelatine was to mix it with orange and lemon juice. If the juice was well chilled, as much as 30 g of gelatine could be given in 8 ounces of juice and the whole taken before the gelatine swelled appreciably. In this manner it was possible for one to take the entire assigned amount of gelatine without distress.

The details of 3 representative experiments are given in Fig. 1. The cross-hatched area to the left indicates the training period; the solid black, the period during which gelatine was administered, and the area to the right, the control or recovery period during which fruit juice alone was given the subjects. It was felt necessary to include this period in order to demonstrate that any effect was due to the gelatine rather than to the increased intake of vitamins.

The record of Subject 7, at the top of the chart, that of a woman medical student, is presented since it is one of 2 records obtained from women subjects showing a semblance of an increase (3%) during the gelatine diet. She received 45 g of gelatine (the equivalent of 11.25 g of glycine) a day during the experimental period. The slight increase noticed is of dubious significance since it may well be assigned to a possible effect of a lengthened training period.

The second graph, that of Subject 1, represents a complete record on a man 25 years old. After the usual period of training, he received 60 g of gelatine a day. The gelatine was continued until the fatigue level appeared to have reached its maximum. In the case of this individual it was at the end of 47 days. At that point the gelatine was discontinued but the 16 ounces of orange and lemon juice maintained. It will be noted that shortly after the cessation of gelatine, the total work output fell off and at the end of 38 days came to a level. At this point the experiment terminated.

Subject 2, whose complete record is also presented, gives a picture similar to that of Subject 1. There is one notable exception in that the response to gelatine is very prompt. This subject, an instructor, aged 33, was of slight build. It is interesting to record at this time that during the gelatine period be gained 10 pounds, 8 of which were retained to the end of the experiment.

In conclusion, it may be said that men, when given adequate amounts of gelatine, are invariably able to increase the amount of work produced before fatigue sets in. The results varied from 37% to 240% increases above the training level. In by far the greater number of subjects the increase was more than double the pregelatine work level. This is not true in the case of women sub-

jects, where no appreciable effect was noticed. It might be supposed that these effects were due to the considerable amounts of orange juice and its vitamins. When, however, gelatine was discontinued and the same amount of fruit juice maintained, the work output rapidly fell to an approximation of the pregelatine level, thereby indicating that the effect was primarily that of the addition of gelatine to the diet. The sexual variation is also of interest from the point of view of the intepretation of the results. As mentioned above, Rose, *et al.*, found a marked sexual variation in the ability to store creatine. These experiments are most suggestive since they indicate a situation comparable to that found in our own experiments. It would seem as though this action of gelatine were particularly concerned with the creatinogenic action of its amino acids, especially glycine.

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Effect of the Experimental Production of an Accessory Blood Supply Upon Normal Kidney.

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The present report is concerned with the effects of the experimental production of an accessory blood supply upon the structure and function of the normal kidney.

Eleven dogs, weighing from 6 to 15 kilos, were used. In 7 of these dogs an accessory circulation was produced in the left kidney and, in 4, in the right kidney. Under general ether anesthesia a mid-line incision was made into the peritoneal cavity. The capsule of the kidney to be used was removed. A small protected arterial clamp was placed upon the renal artery. An incision was made in the antihilar surface of the kidney extending longitudinally from the upper to the lower pole. The incision extended in depth to, but not through, the renal pelvis. Little bleeding occurred from the kidney during this phase of the operation. The omentum was lifted up from the peritoneal cavity and gently packed into the gaping incision in the renal parenchyma. Four sutures of No. 0 chromic catgut were passed through the renal tissue and omentum, which was thus anchored to the kidney. Following the release of the arterial clamp, a moderate amount of bleeding occurred, but this soon ceased.