of nerves into the transplants. *From their very first appearance, the movements exhibited clearly the phenomenon of homologous function,* each reinnervated muscle of the extra limb contracting synchronously with the corresponding muscle of the normal limb.

The animals were kept under observation for many months, throughout which period the phenomenon of homologous function was observed as constantly and as strikingly as in those earlier experiments where the limbs had been in possession of their full sensory control.

*It results from these experiments that sensory messages from the transplants are not instrumental in establishing homologous function.* This is in agreement with the conclusions reached in the earlier work and embodied in the "resonance" conception, according to which the phenomenon of homologous function is a direct manifestation of a primary specific rapport between the impulses generated by the centers on one hand and the individual peripheral organs and their "modulated"[2] motoneurons on the other hand.

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## Glycogen and Water Storage.

ESTHER M. GREISHEIMER AND EDITH GOLDSWORTHY.

*From the Department of Physiology, The University of Minnesota.*

MacKay and Bergman[1] stated that in rabbits there is a tendency for water to be stored in direct proportion to glycogen storage in the liver. The same authors[2] found that in young albino rats, on the average 3.8 gm. of water are stored with each gram of glycogen. That there is a relationship between glycogen and water storage is denied by Puckett,[3] Holmquist,[4] and Bridge.[5]

In view of the difference of opinion noted above, the authors decided to study the question. Adult rats (in most cases) of the Long-Evans strain were used. All the animals were kept on the McCollum Stock Diet I (whole wheat ground, 67.5%, casein 15%, whole milk

2 Weiss, P., *Anat. Rec.*, 1934, **60**, Suppl. p. 30.

1 MacKay, E. M., and Bergman, H. C., *J. Biol. Chem.*, 1932, **96**, 373.

2 MacKay, E. M., and Bergman, H. C., *J. Biol. Chem.*, 1934, **105**, 59.

3 Puckett, H. L., and Wiley, F. H., *J. Biol. Chem.*, 1932, **96**, 367.

4 Holmquist, A. G., *Skand. Arch. für Physiol.*, 1932, **65**, 9.

5 Bridge, E. M., and Bridges, E. M., *J. Biol. Chem.*, 1932, **96**, 381.

powder 10%, butter fat 5.2%, calcium carbonate 1.5%, and sodium chloride 0.8%). The rats were killed by decapitation; the blood sugar was studied by the Shaffer-Somogyi method, the glycogen in a portion of the liver by the method described previously,[6] and the water content in the remaining portion of the liver by drying in an oven to constant weight at 105°C.

In the first study 48 adult and 6 young rats were used. They were not fasted, but allowed the stock diet *ad libitum* until the time of killing. The results for the males and females are combined, and shown in Table I.

TABLE I.

| | Liver Wt. | % Glycogen | % Water | Glycogen per liver (gm.) | Water per liver (gm.) | Blood Sugar (mg. %) | No. of rats |
|---|---|---|---|---|---|---|---|
| Min. | 4.5946 | 2.17 | 68.65 | 0.183 | 3.23 | 73.63 | |
| Max. | 15.4192 | 6.76 | 70.92 | 0.917 | 10.79 | 113.47 | |
| Aver. | 9.3113 | 4.30 | 69.90 | 0.398 | 6.51 | 96.06 | 54 |

The relationship between glycogen and water content was tested by the determination of the correlation coefficient. When the percentage of glycogen and the percentage of water are used in the calculations, the correlation coefficient is $+.202 \pm .088$, which would indicate a lack of correlation. However, when the absolute values, as glycogen per liver and water per liver, are used in the calculations, the correlation coefficient is $+.745 \pm .041$. This indicates a significant relationship. Hence, in rats which have not been fasted, but allowed the stock diet *ad libitum* until the time of killing, the water is found to increase as the glycogen increases, by the method of random sampling.

In the same group of rats, other relationships were tested. When the blood sugar and the liver glycogen are studied, no relationship is found between the two. The correlation coefficient for blood sugar and percentage of liver glycogen is $-.065 \pm .091$, and that for blood sugar and absolute glycogen is $-.224 \pm .087$. We must conclude that in rats which have not fasted there is no relationship between the blood sugar and the liver glycogen.

Likewise, there is no relationship between the blood sugar and the water content of the liver, as shown by a correlation coefficient of $+.050 \pm .091$ for blood sugar and percentage of liver glycogen, and $-.154 \pm .090$ for blood sugar and absolute water.

In the second study, 43 rats were used. These were kept on stock

[6] Greisheimer, E. M., and Johnson, O. H., *Am. J. Physiol.*, 1929, **90**, 369.

diet until the night before killing; they were then fasted 12 hours, and subsequently divided into the following 5 groups. The rats in Group 1 were killed after the 12-hour fast; those in Group 2 were allowed stock diet *ad libitum* for 1½ hours before killing; those in Group 3, the same for 2½ hours; those in Group 4, the same for 3¼ hours, and those in Group 5, the same for 4 hours before killing.

The results for males and females are combined and shown in Table II.

TABLE II.

| No. of rats | Liver Wt. | % Glycogen | % Water | Glycogen per liver (gm.) | Water per liver (gm.) | Blood Sugar (mg. %) |
|---|---|---|---|---|---|---|
| I (9a*) | 7.784 | 0.315 | 69.69 | .025 | 5.424 | 82.66 |
| II (5a + 4y) | 6.905 | 1.04 | 71.32 | .066 | 4.926 | 109.38 |
| III (4a + 4y) | 6.177 | 1.67 | 70.99 | .100 | 4.379 | 108.05 |
| IV (4a + 4y) | 7.264 | 2.47 | 70.93 | .176 | 5.143 | 106.65 |
| V (3a + 6y) | 5.939 | 2.87 | 70.94 | .168 | 4.199 | 109.82 |

* a = adults; y = young.

The authors did not find such close agreement as MacKay and Bergman[2] between the water storage and glycogen, in this study. However, the rats were not all of the same age, and they were fed stock diet instead of glucose and fructose. The time intervals varied in the 2 studies. This study does show that glycogen is deposited rapidly after feeding, and that it increases with the time elapsing between feeding and killing.

*Summary.* With a large group of rats taken at random, and kept on stock diet until killed, a high degree of correlation is found between the absolute glycogen and water content in the liver. With smaller groups, fasted for 12 hours, and fed the stock diet, then killed at intervals varying from 1½ to 4 hours, the relation between the glycogen and water content is less marked.

There is no correlation between the blood sugar and the liver glycogen, nor between the blood sugar and the water content of the liver.