for the higher value of the liver expressed as per cent of body weight. The lowest glycogen content was found in the fasting group, but the values for the glutamic acid- and glycine-fed animals are so slightly above the fasting level, that we may consider no glycogen to be formed from either of these acids in the present method of investigation.

Glycogen was readily formed from alanine, as expected, and the feeding of cystine was likewise followed by definite glyconeogenesis.

The surprising result was the evident formation of glycogen from tyrosine. This amino acid is treated as ketogenic, in diabetic diet calculations, but under the conditions of our experiments, it appears to be antiketogenic.

The total lipid content of the liver is low in the unstarved rats, quite high in those fed glutamic acid, and between 5 and 6% in the other groups.

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Correction for Undercooling in Material of High Solid Content.

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As a solution is cooled in a freezing-point determination, crystallizing does not start at the freezing temperature. The temperature falls below the freezing-point, to an extent varying in different cases, before the freezing process commences. As soon as ice does start to form, the temperature climbs rapidly toward the freezing-point. The heat for this rise of temperature is derived from the freezing process, the latent heat of fusion of ice being 80 calories. The formation of ice is equivalent to the removal of water, and hence the solution will be concentrated. The freezing-point observed will, therefore, represent a solution more concentrated than the original solution; or, to express the fact differently, the freezing-point depression observed will be greater than the true depression for the solution.

The solution, if the amount of solid present is so small that it can be neglected, will be concentrated s u/1 times for u degrees of undercooling (Jones[1]), where s equals the specific heat of the solu-

[1] Jones, H. C., *Z. f. Phys. Chem.*, 1893, **12**, 624.

tion and l the latent heat of fusion. Thus the true freezing-point, Δ, will equal the observed freezing-point, Δ^1, minus $\frac{s\,u\,\Delta^1}{l}$.

$$\Delta = \Delta^1 - \frac{s\,u\,\Delta^1}{l} \quad (1).[2]$$

Assuming the specific heat to be unity and l to be 80,

$$\Delta = \Delta^1 - \frac{u\,\Delta^1}{80} \quad (2).*$$

However, if there is a large percentage of solid present in the material, then, for the same amount of undercooling, there will be a greater concentration in such material than in a solution containing only a negligible amount of solid. The same quantity of ice must be formed in each case (assuming the specific heats to be the same), and hence the concentration will be greater in the material of high solid content. If the solids are considered, the correction equation becomes

$$\Delta = \Delta^1 - \frac{s\,u\,\Delta^1}{80\,w} \quad (3).$$

The term, s, is the specific heat of the material, and w represents the fraction by weight of water acting as a solvent (more exactly, this water plus the soluble constituents dissolved in it).

It is instructive to obtain undercooling data for materials of widely varying water contents. Solutions of NaCl and KCl have been taken as examples of solutions of low solid content. The observed freezing-point, Δ^1, was measured for different degrees of undercooling, and the results were recorded on coordinate paper, Δ^1 being plotted against undercooling. It is possible to obtain the true freezing-point, Δ, from such a graph; for Δ corresponds to Δ^1 at zero undercooling, and can hence be obtained from the graph by extrapolation.† By substituting in equation (3) the value obtained for Δ and also a value of Δ^1 and its corresponding u (obtained from the graph), w can be calculated. With the NaCl and KCl solutions, w ranged around unity. This result is to be expected since the solid content of a 1% NaCl or KCl solution is negligible from the present viewpoint.

In the same manner, w has been determined for whole blood, serum, and corpuscles. However, the values obtained did not correspond to the actual total water contents of such material. For ex-

[2] Harris, J. A., and Gortner, R. A., *Am. J. Bot.*, 1914, **1**, 75.

* The amount of heat required to raise the temperature of the mercury and glass of the thermometer and of the glass of the freezing-point vessel is not considered in this correction. However, the specific heat of mercury is only 0.033 at 0°C., and that of glass is approximately 0.2.

† This is practically a straight line relationship.

ample, in an experiment on the corpuscles of beef blood, a value of 0.34 for w was obtained. The fraction of water in beef corpuscles is about 0.60. The discrepancy may possibly be explained by the presence of water not active as a solvent ("bound water") at the temperature of the freezing-point. Accordingly, the bound water content of the beef corpuscles in the above experiment is 26%.

Thus the equation, $\Delta = \Delta^1 - \frac{s\,u\,\Delta^1}{80\,w}$, may be used in correcting for undercooling in the determination of the freezing-point in solutions of high solid content, the w in the equation for a given material being determined from freezing-point data on undercooling. Where large amounts of solid are present, it is important to make this correction. The undercooling data also provide a method for determining bound water in a rough manner; that is, the fraction of total water present minus the w of the above equation equals the fraction of the bound water.

NOTE: Dr. F. H. MacDougall has kindly developed an equation in which the specific heats of the various components are taken into account separately.

$$\Delta = \Delta^1 - \left[1 + \frac{(w_2 + w_3\,c)}{w_1}\right]\frac{u}{80}\Delta^1.$$

In this equation w_1 equals the fraction of actual solution, w_2 the fraction of bound water, w_3 the fraction of solid material, and c the specific heat of the solids. The specific heats of the solution and of the bound water are assumed to be equal to unity.

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Action of Ultra-Violet Rays on New and Old Bacterial Cultures.

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Cultures of bacteria placed on agar are as a rule easily killed by exposure to ultra-violet light from a quartz mercury arc. The amount of radiation necessary for devitalization depends upon several factors. Perhaps the most intricate of these is the variation of resistance with age. This relation between resistance and age has not been determined in detail. The following study was aimed as a contribution to our knowledge in this respect.

In the following experiments a new Victor quartz mercury arc lamp was used without any filter. The current was 4.5 amperes at 65 volts and the distance from burner to plate was 24 inches.