RU of Antuitrin S* daily for 5 days after which the dosage was increased to 10 RU daily until 25 days had elapsed. Examination of the peritoneal linings at that time showed that ciliation had not occurred in any region.

7486 C

Volume and Total Number of Glomeruli in Kidney of White Rat Estimated by Precision Methods.

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The general principles of measurement of microscopic figures by projectometric methods have been treated in another communication,[1] and applications to the measurement of islands of Langerhans in the pancreas have been presented.[2, 3] The greatest difficulty in this work was due to the enormous variations in their volume and shape. Since this difficulty was far less evident in the case of the glomeruli of the kidney an investigation of this field seemed indicated, and we wish to give at present some of the results so far obtained.

It has been thought preferable to make estimates free from the assumption of spherical form for glomeruli wherever possible, but to use this to furnish an independent check. However, in the material used, it was found that areas of glomerular *particles* in sections (7 micra thick) could be approximated satisfactorily by comparison of their projected images with circles of known size; and this was done rather than trace and measure them with a planimeter. A glomerulus was considered to *belong* (in the sense previously[1] defined for *islets*) to a given section if its greatest cross-sectional area lie therein. Thus it was possible from random samples and assumption of approximate spherical form to estimate directly mean volume and diameter of glomeruli in a given region. However, we are interested in data more comprehensive than this, and, if possible, free from the assumption of sphericality; *e. g.*, total glomerular tissue volume (I_s) in the sample region. Previous

1 Thompson, W. R., *Biometrika*, 1932, **24**, 21.

2 Thompson, W. R., Hussey, R., *et al.*, *Biometrika*, 1932, **24**, 27.

3 Thompson, W. R., Tennant, R., and Hussey, R., *Science*, 1933, **78**, 270.

attempts in this direction have been based upon treatment as if the section were opaque, *i. e.*, attempting to measure all areas of glomerular (or *islet*) tissue in the first presented surface; but it is much easier in practice to focus upon the greatest cross-sectional area in the section of each glomerular particle. From the simple assumption that there may be found in serial sections only one maximal cross-sectional area for each glomerulus, it can be demonstrated that the sum of all such areas in a section except those of glomeruli actually *belonging* to it is the mean *expected* value of the sum of *all* glomerular area in a plane cross section (*e. g.*, the first presented surface). Furthermore, it is important to note that the expected mean number of particles in a section per glomerulus (or *islet*) belonging, $M_{(\eta)}$, is one greater in the case of transparent sections than if merely the first presented surface of each is considered; *i. e.*, $M_{(\eta)} = M_{(d)}/t + 1$, where d is the glomerular diameter and t is the section thickness.

The present experimental work has to do with measurements on the kidneys of white rats, from a colony which has been maintained for a long time in the department of Physiological Chemistry. One kidney was removed for study from each of 4 rats at an approximate age of 58 days, and the animals maintained with the object of studying similarly the condition of the other kidneys 90 days later. The volume by displacement of 5% formalin was measured; and the kidney fixed in Zenker-formol solution, double imbedded and serially sectioned (at 7 micra thickness). Then by projectometric methods similar to those previously described,[1, 2] the volume of the imbedded organ was estimated and the ratio, λ^3, of this to the displacement volume of the fresh tissue found in each instance. Thus for the 4 kidneys first mentioned, $\lambda^3 = 0.547$, 0.590, 0.433 and 0.538. However, various tissue volumes compared from organ to organ showed less variation when expressed as in the *shrunken* state. Thus for these kidneys were found the following means and average deviations: for total kidney volume (T_o) $0.336 \pm .014$ cm.^{3}, for total glomerular volume (I_o) $7.25 \pm .59$ mm.^{3}, and for mean glomerulus volume (V_o) $2.90 \pm .26$ ($10^5\mu^3$). The estimated total number of glomeruli, N_o, in the organ was 28,400, 27,100, 25,900 and 19,800, respectively, in the 4 kidneys; mean $N_o = 25.3 \pm 2.7$ thousand. $V_o = I_o/N_o$ in the above estimates, but the mean glomerulus volume, $M_{(v)}$, was estimated directly by means of the spherical assumption at 6 equidistant intervals in each kidney. The means of these 6 values and a.d. for each of the 4 kidneys were $2.92 \pm .21$, $2.91 \pm .27$, $2.62 \pm .09$, and $3.41 \pm .17$; and the mean

of means was 2.97 with a.d. = .23 (all expressed in $10^5.\mu^3$). These values serve as a rough check on those previously given, but would be useless for this purpose were it not for the approximate stability of $M_{(v)}$ in the 6 sampled regions of each organ. However, a basis of strict comparability of the 2 methods of estimation may be had by estimating for each sample the total glomerular tissue contained (I_s), once as already mentioned, and again by the expected value of $I_s = Z_s.M_{(v)}/M_{(\eta)}$, where Z_s is the number of glomerular *particles* in the sampled region; summing each set of estimates for a given organ and obtaining the ratio of these sums. These ratios for the 4 kidneys were 1.063, 0.995, 0.980 and 1.006, respectively; and for 2 others (experimental and control) 1.032 and 0.995, respectively. This we feel indicates a far greater precision and reliability than has been obtained previously in work of this character. Neglect of the effect of focusing upon the greatest cross section of each particle in the transparent section instead of the first presented surface would have introduced an error of about 13%.

Estimates of the total number of glomeruli in the rat kidney have been made by various workers, notably by Moore,[4] whose findings agree closely with our own. However, we feel that the methods suggested above have some advantage in precision over those used previously, and in addition permit a simultaneous estimation of various volume relations.

7487 C

Antistreptolysin Content of Sera from Cases of Recurrent Tropical Lymphangitis.

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Todd[1] has shown that there are in the sera of patients suffering from diseases caused by hemolytic streptococci, antibodies that neutralize *in vitro* streptococcal hemolysin. Todd[1] and Coburn[2] have demonstrated that these antibodies are found in abnormally

4 Moore, R. A., *J. Exp. Med.*, 1929, **50**, 709.

1 Todd, E. W., *Brit. J. Exp. Path.*, 1932, **13**, 248.

2 Coburn, A. F., and Pauli, R. H., *J. Exp. Med.*, 1932, **56**, 651.