exhibit as much as five times more buffering action than another peptone at the same hydrogen ion concentration. In general, the peptones tested showed the highest degree of variation in buffering effect in the zone of the hydrogen ion concentration limited between $P_H = 9$ and $P_H = 8$, and the lowest degree of variation in the zone between $P_H = 4$ and $P_H = 5$. As to the absolute concentration of buffering salts, these were found in most peptones to be the highest at the zone of the lowest concentration of the hydrogen ions and not in the zone of neutrality or of high hydrogen ion concentration where the buffering action would be most desirable for the use in media for identification of bacteria.

Below is a table showing the relative buffering action of peptones at various P_H levels.

Peptone.	PH 9–8.	PH 8–7.	PH 7–6.	PH 6–5.	PH 5–4.
Difco	9	5	3.5	5	11
Proteose	11	8	4	5	15
Witte	6	6	5	4.5	10
Aminoid	34	11	7	6	14
Fairchild	12	8	9	7	14
Roche	13	8	5	4	10
Armour	20	11	9	7	12

This work is a part of the investigation of food poisoning, conducted under the direction of Dr. M. J. Rosenau, Professor of Preventive Medicine and Hygiene, Medical School of Harvard University. The investigations are made under the auspices of the Advisory Committee on the Toxicity of Preserved Foods of the National Research Council, and under a grant of the National Canners' Association.

9 (1756)

Some mathematical relations in the Wassermann reaction.

By STERNE MORSE.

[*From the Psychiatric Institute, Ward's Island, New York City.*]

Von Krogh's[1] equation, $y = x^n/(x^n + k)$, has not received the the consideration by immunologists which its very close statement of the facts in several immune mechanisms capable of numerical

[1] Von Krogh, *Journal of Infectious Diseases*, 1916, xix, 452.

expression would warrant. It will in general, for instance, closely state the amount of hemolysis in a system where complement is the only independent variable, x, y, is the proportion of hemolysis read colorimetrically, and n and k are constants. It is often more convenient to use it in the form of $x^n = k[y/(1 - y)]$. If this expression is put into logarithmic form,

$$n \log x = \log k + \log \frac{y}{1 - y},$$

the expression is linear when expressed graphically, that is, if plotted on logarithmic paper, the data will fall more or less accurately on a straight line whose slope numerically expressed will equal n, and whose intercept on the axis y will be the reciprocal of k. Moreover, if two complements are compared, the intercept of their graphs on the axis of x will be reciprocals of their concentration referred to any unit in which we may choose to express such concentrations.

In theory and this is to a large extent borne out in practice, this intercept on the axis of x is independent of the value of n.

n varies in the case of blood cells with the individual from which the blood is drawn, with the age of the blood cells, and with the treatment which they have experienced. It is low when the cells are suspended in Ringer's solution, high when they are suspended in salt solution, is increased with the age of cells and in general with harmful conditions, such as the presence of antiseptics in small concentration and the like. It decreases as the concentration of cells is increased. It varies under the conditions and

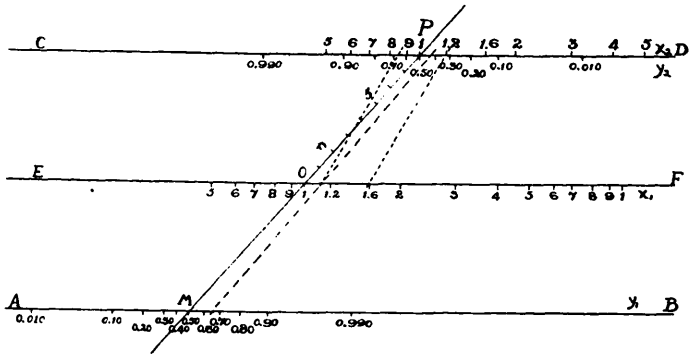

FIG. 1. Nomogram for solution of the equation $y = x^n = x^n + k$, for n.

technic used in this laboratory[1], from 2 to 6, generally around 3.5.

In order to calculate the constants of the above equation from numerical data, I have devised the nomogram illustrated in Fig. 1. This enables the value of n to be directly ascertained from any pair of values of x and y, $(x_1, y_1,)$ and (x_2, y_2), where as before x is

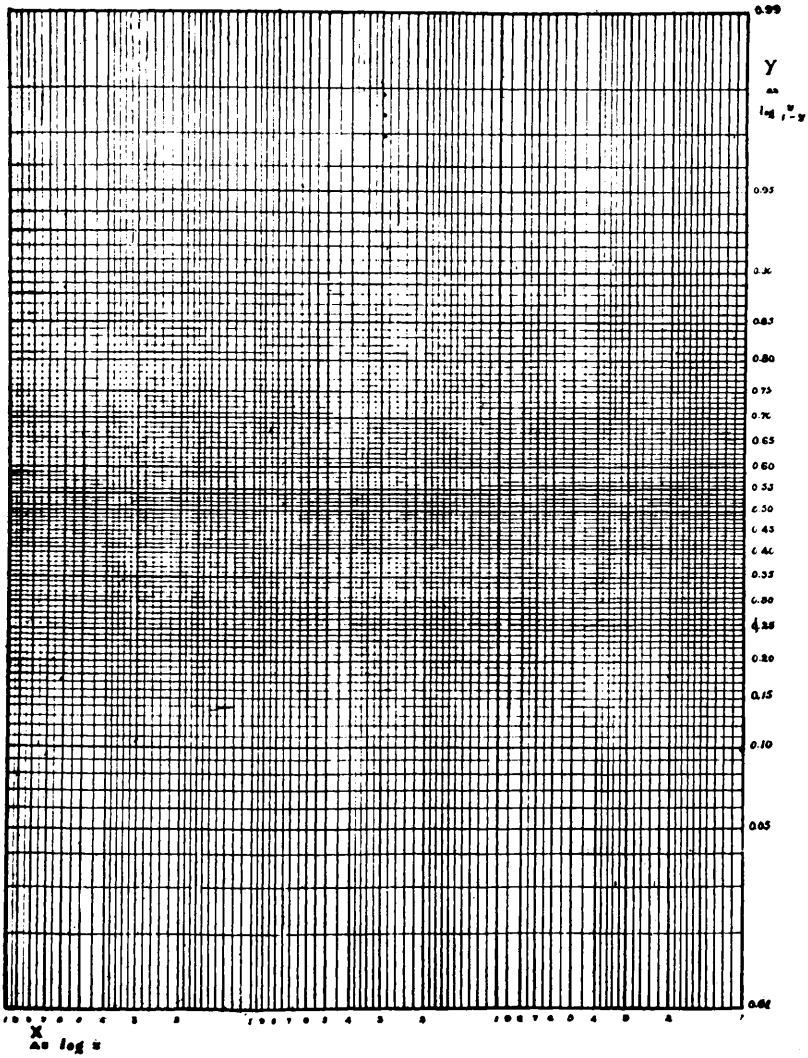

FIG. 2. Coördinate paper — log $y/(1 - y)$ *vs.* log x.

[1] Morse, *Psychiatric Bulletin*, 1916, i, 47.

the independent variable, complement, and y is the proportion of cells which are hemolyzed. Possibly a more convenient method still is the use of the coördinate paper shown in Fig. 2, where log $[y/(1 - y)]$ is directly compared with log x. In the case of the nomogram a straight edge is laid between the values of y_1 and y_2 on the lines AB and CD respectively and the point where it crosses the line EF marked. A line is then drawn between the values of x_1 and x_2 on EF and CD respectively and this line is moved parallel to itself until it passes through the point where the first line crosses EF. It will then intersect the line OP at the value of n required to satisfy this pair of values. In the use of the coördinate paper the values are plotted directly and the slope measured. This second method has the advantage over the first of being dependent on all values of x and y and not merely upon a pair of values.

The Wassermann reaction is in the last analysis an estimation of complement after certain procedures are performed. This method is, it is believed, the nearest to an absolute measure of complement which has yet been devised and has a precision under favorable conditions of 3 per cent. or better.

The reaction between syphilitic antibody-antigen complex and complement appears to follow the same law, wherein the logarithm of the proportion between the amount of complement absorbed to that unabsorbed varies linearly with the logarithm of the amount of antigen antibody complex present, the slope of the graph in this case ranging round 1 or a little higher.

If these considerations are valid, one can make certain statements as to the Wassermann procedure which are at variance with the theory of the reaction as ordinarily conceived. In the first place, the estimation of complement should be performed under such conditions as to bring the amount of hemolysis in the neighborhood of 50 per cent., which corresponds to the value log $[y/(1 - y)] = 0$. The precision of measurement of complement by using this point can be calculated to be and is in fact at least 10 times as great as the precision obtainable by the common methods. In the second place, a true measure of the amount of syphilitic antibody antigen complex is given, not by the absolute amount of complement absorbed, but by the proportion which

the amount absorbed bears to that unabsorbed. Thirdly, it follows from the second conclusion that the actual amount of complement which is used in the reaction is not important within limits, except as it affects the slope of the plotted logarithmic curve. This gives a method susceptible of considerable accuracy for the comparison of any unknown syphilitic serum or spinal fluid with a standard syphilitic serum which has previously[1] been shown to be indefinitely preservable by appropriate technic.

10 (1757)

Experiment in new method of therapy of paralysis agitans.

By M. H. WEINBERG and T. SCHUBB.

[*Pittsburgh, Pa.*]

Starting out from the premise that paralysis agitans is due to hyperparathyroidemia, as advocated by several observers, we proceeded to prepare a parathyroidectin substance for the treatment of this condition. Experiments were conducted on rabbits and on goats. The two external parathyroid glands of the goat were removed, and after forty days the blood of the goat was withdrawn and glycerinized. The administration of this blood to Parkinsonian patients seems to show promising results. Further study of this method of therapy is now under way.

11 (1758)

Typing of different strains of Bacillus botulinus by immunologic methods.

By J. BRONFENBRENNER, M. J. SCHLESINGER and S. C. CALAZANS.

[*From the Department of Preventive Medicine and Hygiene, Harvard Medical School, Boston, Mass.*]

A number of strains of *Bacillus botulinus* isolated both abroad and in this country represent a fairly uniform group in so far as their cultural characteristics and the symptoms produced by their toxin are concerned. However, in respect to neutralization of toxin by antitoxin there exist two sharply distinct groups of this organism, thus suggesting that in fact we are dealing with two distinct antigens.

[1] *loc. cit.*