growth rate of *T. geleii* can be increased by the addition of 1.0 mg per ml of sodium acetate.

The requirement of the different organisms for protogen differs widely. The requirements of *T. geleii,* the corynebacterium, and *L. casei* for protogen are respectively 0.5, 0.01 and 0.025 unit per ml for maximum growth. The protogen requirements for *L. casei* can be replaced by 0.25 mg of sodium acetate per ml.

Summary. An unidentified gram-positive bacillus has been found which requires protogen for growth in about one-fiftieth of the concentration required by *Tetrahymena geleii.*

6. Kidder, G. W., and Dewey, V., *Arch. Biochem.,* 1949, v20, 433.

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Applicability of a Differential Analyzer to Determination of Protein Fractions by the Electrophoretic Technic. (17976)

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This laboratory has found it advantageous to use a differential analyzer in place of a planimeter in connection with determination of concentrations of plasma protein fractions from electrophoretic patterns. The differential analyzer is an analogue computer developed at the Massachusetts Institute of Technology under the direction of Dr. Vannevar Bush. One was recently acquired by Wayne University. Its use was made available to us and the work was carried out at Wayne University Computation Laboratory under the direction of Prof. Arvid W. Jacobson.

Although the primary purpose of the analyzer is the solution of differential equations(1) the principles upon which it operates are quite simple. All quantities involved in the calculations are represented by the rotation of shafts. The fundamental unit is the integrator which is shown in Fig. 1. The disc A turns the wheel B by friction. Hence, a slight amount of rotation, ΔW of wheel B will be proportional to the product of the corresponding rotation, ΔV of disc A and the distance U of wheel B from the center of A; *i.e.,*

$$W = k \cdot U \Delta V$$

Thus, if u and v vary, the rotation of wheel B will be represented by the integral

$$W = k \int U dV.$$

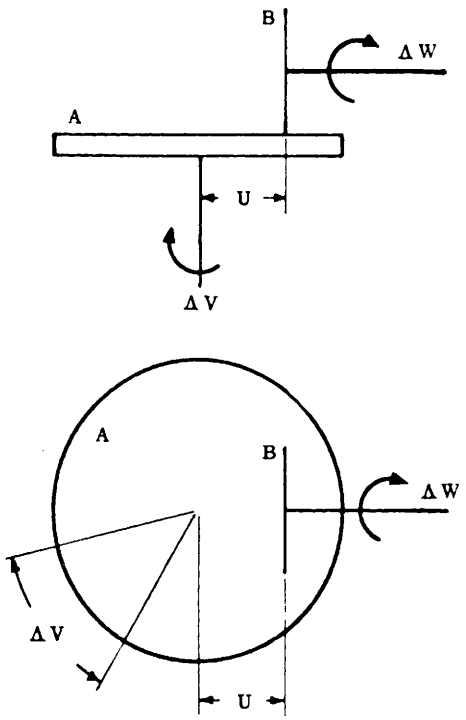

FIG. 1.
Integrator.

Fig. 2 shows a schematic diagram of the entire operation. In this drawing the mecha-

1. For a complete discussion of the differential analyzer see Bush, V., and Caldwell, S. H., *J. Franklin Inst.,* 1945, v240, 255.

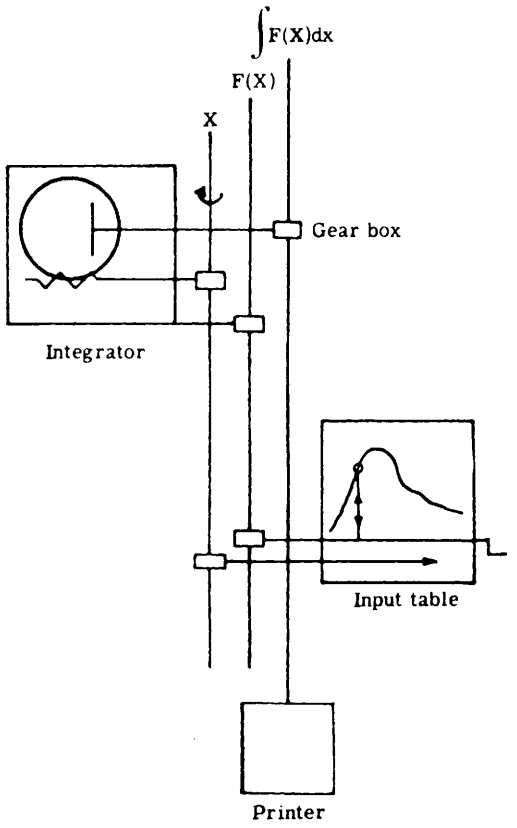

FIG. 2.
Schematic drawing of entire operation.

nism of Fig. 1 is represented by the symbol marked integrator. The symbol marked input table is a function unit used to generate the function F(X) in the machine. A graph of this function is plotted on the table, and the machine moves the carriage, to which an index or bull's-eye is attached, horizontally across the input table, while the operator works the crank in such a way as to keep the bull's-eye on the curve. The speed of the horizontal motion of the bull's-eye can be varied by the operator, depending on the slope of the curve to be followed. This arrangement, among other things, accounts to a large extent for the high accuracy of the machine. While the planimeter operator has to follow the curve along both dimensions of the plane with the point of a needle, the operator of the differential analyzer need concern himself with the vertical adjustment only. Moreover, studies at M.I.T. have shown that the human eye can make optimal decisions in following the curve by means of the circle of a bull's-eye, whose area is bisected by the curve.

The operation of the machine begins with application of power to rotate the shaft designated X. This shaft is connected to a cross shaft which moves the bull's-eye across the input table where the operator generates the function F(X) by means of the crank. The integrator integrates F(X) with respect to X, and this quantity is represented by the rotation of the top shaft, which is directly connected to the printer. The printer has a capacity of 5 digits and may be actuated by the operator at any desired moment.

The tracing of a typical ascending electrophoretic pattern is shown in Fig. 3. The areas to be evaluated in order from left to right represent concentrations of the following plasma protein fractions: albumin, alpha$_1$, alpha$_2$ and beta globulins, fibrinogen, gamma globulin and the delta anomaly.

Table I shows a comparison of the results obtained by measuring the areas of three tracings 5 times on the differential analyzer, and 5 times by means of a precision disc planimeter(2). The results clearly show that the differential analyzer measurements have

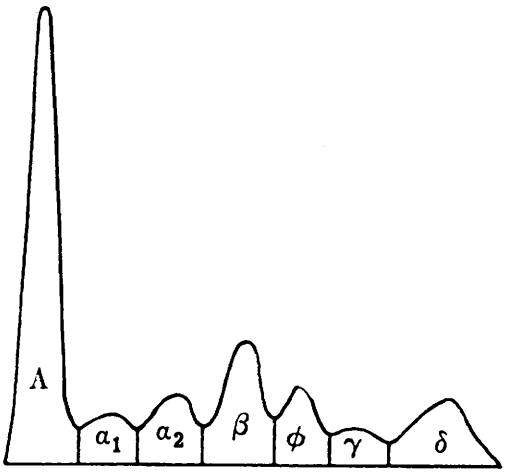

FIG. 3.
Typical electrophoretic pattern.

2. G. Coradi, Zurich, Switzerland.

TABLE I.
Means and Standard Deviations for 5 Measurements of 3 Tracings by 2 Methods.

	Differential analyzer		Disc planimeter	
	Mean Sq. in.	Stand. dev.* Sq. in.	Mean Sq. in.	Stand. dev. Sq. in.
	Tracing No. 1			
Albumin	1.302	.002	1.288	.048
$Alpha_1$	.106	.005	.113	.014
$Alpha_2$	.228	.008	.227	.005
Beta	.310	.005	.313	.007
Phi	.204	.004	.202	.005
Gamma	.407	.009	.401	.008
Delta	.362	.014	.361	.007
Total area	2.918	.045	2.905	.066
	Tracing No. 2			
Albumin	1.244	.006	1.237	.010
$Alpha_1$	.162	.005	.168	.006
$Alpha_2$	.291	.002	.295	.008
Beta	.386	.002	.384	.010
Phi	.223	.002	.223	.002
Gamma	.480	.005	.484	.006
Delta	.406	.007	.404	.008
Total area	3.190	.028	3.194	.028
	Tracing No. 3			
Albumin	1.576	.006	1.526	.052
$Alpha_1$	.179	.004	.180	.008
$Alpha_2$	.243	.003	.248	.007
Beta	.393	.002	.395	.005
Phi	.160	.003	.163	.010
Gamma	.298	.006	.313	.016
Delta	.398	.005	.408	.009
Total area	3.248	.020	3.233	.062

*Standard deviation $S = \sqrt{\frac{\Sigma(x_1 - \bar{x})^2}{n-1}}$.

greater precision than those obtained with the planimeter, and that the greatest actual differences arise in measurements of the largest areas, namely those of the albumin peak, and of the total area of the pattern. Considering percentage deviations from the mean, the maximum deviation for the set of 120 measurements on the differential analyzer was 7.3%, with 88% of the deviations below 2%, and 31% below 0.5%. The same set of measurements by means of the planimeter yielded a maximum deviation from the mean of 22.1%, with 61% of the values below 2.0% and 21% below 0.5%.

In addition to obtaining more accurate results, use of the differential analyzer will save a great deal of time, especially when comparatively large numbers of tracings can be run at one time. While it takes approximately 2 hours to set up the mechanism for the operation, the time required for measurement of a tracing is only 10 minutes. Use of the planimeter requires approximately 1 hour per tracing, since the lack of precision made it necessary to measure each tracing at least twice.

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Simultaneous Bilateral Determinations of Cerebral Blood Flow and Arterial-Cerebral Venous Oxygen and Glucose Differences.* (17977)

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The validity of the nitrous oxide procedure for measuring cerebral blood flow depends upon the assumption that blood obtained from one internal jugular bulb is representative of mixed cerebral venous blood. Since the brain is actually a heterogeneous organ, comprised of a wide variety of cell types, and with different rates of metabolism in its various parts, the nitrous oxide technic at best yields an average value for the blood flow through and the metabolism of these different areas. Unless the blood draining these parts is reasonably well mixed, or at least consistently distributed, it is manifestly impossible to reach valid conclusions concerning

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