of Mechanical Engineers will be held at Pittsburgh from June 19 to 22. In addition to a full program of technical papers, there will be a panel discussion on developments in industrial furnaces; a symposium on instrument controls action and one on controlled atmospheres in metals engineering. Igor I. Sikorsky will be the speaker at the dinner of the society on the evening of Wednesday, June 21.

THE Washington Branch of the American Association of Scientific Workers has arranged a symposium for Friday evening, June 16, at 8 o'clock, in the Auditorium Archives Building on "The Utilization of Scientific Personnel in Wartime" under the chairmanship of R. H. Montgomery, economic adviser to the executive director of the Foreign Economic Administration. The speakers are Dr. Vannevar Bush, director of the Office of Scientific Research and Development, and Colonel John N. Andrews, office of the director of the Selective Service System.

THE Fifth Conference on Science, Philosophy and Religion will meet at the Men's Faculty Club of Columbia University over the week-end of September 7. In accordance with the practice adopted last year, attendance will be limited to members and participants in the program. There will be no public meetings.

AT the ninety-seventh annual general meeting in London of the British Palaeontographical Society, a committee was appointed to consider plans for the commemoration in 1947 of the centenary of the society.

THE John and Mary R. Markle Foundation has authorized a grant-in-aid of $5,400 annually, for a two-year period, in support of research on experimental renal hypertension at the University of Illinois College of Medicine, Chicago. The work, which was initiated in 1942, under a two-year grant of $7,000 from the foundation, is being conducted under the direction of Dr. George E. Wakerlin, professor of physiology and head of the department.

THE Sugar Research Foundation has made grants amounting in all to $104,000 for research on sugar to the following recipients: Dr. Ancel B. Keys, professor of physiology at the University of Minnesota; Dr. Julian A. Boyd, associate professor of pediatrics at the Iowa State University; Dr. Frederick J. Stare and Dr. A. Leroy Johnson, both of the School of Medicine and Public Health of Harvard University; Dr. Melville L. Wolfrom, professor of chemistry at the Ohio State University, and Dr. Carl Neuberg, professor of chemistry at the Washington Square College of New York University.

THE University of Arizona is acquiring the private herbarium of Dr. Forrest Shreve, of the Carnegie Institution of Washington. The collection contains 30,000 specimens and is recognized as an excellent representation of the Mexican flora. About half the specimens are from Mexico, mainly from the northern half of that country. The other half of the collection is chiefly from the southwestern states with about 1,500 sheets from Maryland, Georgia and Alabama, and an undetermined number from Jamaica. The Mexican plants include a considerable number of old collections made by Pringle, Palmer, Marcus Jones and Purpus. The more recent material includes sets of nearly all the important collections that have been made in Mexico since 1930. Included among the specimens are nine types, about 200 topotypes and about 300 isotypes.

CHANGES in the undergraduate curriculum of the Massachusetts Institute of Technology to meet the special requirements of education in science, engineering and architecture after the war have been approved by the faculty. The plan is the result of months of study by a faculty committee appointed to consider simplification of courses. Members of the committee were Professor Earl B. Millard, *Chairman;* Professor Leicester F. Hamilton, Registrar Joseph C. MacKinnon, Professor George W. Swett, Professor Arthur L. Townsend, Professor Carlton E. Tucker and Professor Bertram E. Warren. The most important feature of the revision is a coordinated four-year program in the humanities and social sciences which emphasizes the long-established educational philosophy of instruction of the institute in the ethical and social implications of science and technology.

DISCUSSION

A NOTE ON EQUATIONS OF GROWTH[1]

IT is an altogether too well-known fact that the growth of diverse cellular populations can not be described by a single growth equation, merely by changing the numerical values in the "constants" so as to fit each case. Much less realized is the equally evident fact that a single differential equation with

[1] In accordance with Art. 113(2) U. S. Navy Regulations, the opinions or assertions contained herein are the private ones of the writer, and are not to be construed as official or reflecting the views of the Navy Department or Naval Service at large.

fixed constants is generally unable to describe even the entire lifetime of one cell community. The first of these serious difficulties suggests that an equation may be too committing and limited and is thus unable to grasp the "common denominator" of all growth. A promising solution to this problem is to fix attention on the form of the differential or integro-differential equation. This point of view has been argued elsewhere.[2] The function most commonly used, and for which there is considerable theoretical justification, is the polynomial in N,

$$\frac{dN}{dt} = h_1 N^{\gamma_1} + h_2 N^{\gamma_2} + \ldots\ldots\ldots + h_m N^{\gamma_m} \qquad (1)$$

where N is the cell number (or some parameter linearly proportional to it), and the h_j are aptly[3] called the vital coefficients. In recognition of the first-mentioned difficulty of the growth problem, it is to be understood that only some of the terms in (1) will appear, depending on what sort of growth is being analyzed. The second difficulty—with which this paper is concerned—leads to the further admission that the h_j are in some way dependent on time. This situation has been clearly realized by Kostitzin (*ibid.*), who has suggested an analytic treatment based on dividing up the life span of the colony into physiological phases. He then writes for each phase one equation with constant vital coefficients. The values of these constants, however, change discontinuously from phase to phase, while the final value of N in one phase becomes the initial value of N in the next. While in a qualitative sense the notion or discrete physiological phases is useful, it is obvious that a full treatment of the problem must be based on analyzing continuous changes. This involves giving rational interpretations to the vital coefficients, and therefore explicitly predicting how they shall vary in time. An attempt of this sort has been made elsewhere.[4] In certain cases the resulting differential equation is directly integrable. Such a procedure is what might be called the direct solution of the growth problem.

Usually, however, it is impossible to solve the differential equation by any practical method, and one must wait upon the evolution of other procedures. In the meantime the following simple analysis can be of considerable value.

Let us suppose that on the basis of a knowledge of the physical situation one writes the differential equation of the system as,

$$\frac{dN}{dt} = \sum_{j=o}^{j=m} h_j N^{\gamma_j} \qquad (2)$$

Defining two differential operators, H:

$$H^o \equiv 1$$

$$H^1 \equiv \frac{1}{\frac{dN}{dt}} \frac{d}{dt}$$

We may generate from (2) the set of equations by successive application of the H:

$$H^i\left(\frac{dN}{dt}\right) = \sum_{j=o}^{j=m} h_j \left[\frac{\gamma_j!\, N^{\gamma_j - i}}{(\gamma_j - i)!}\right], \quad i = 0, 1, 2 \ldots\ldots \qquad (3)$$

So far as the h_j are concerned (3) is a linear set. Letting i run to the value m, it is evident that the values of all the h_j *at the point* (N, t) can be determined by usual methods as,

$$h_j = \frac{\begin{vmatrix} p_{oo} & p_{o1} & \ldots\ldots p_{jo-1} H^o \frac{dN}{dt} & \ldots\ldots p_{on} \\ \ldots\ldots & \ldots\ldots & \ldots\ldots & \ldots\ldots \\ p_{io} & p_{i1} & \ldots\ldots p_{ij-1} H^i \frac{dN}{dt} & \ldots\ldots p_{in} \\ \ldots\ldots & \ldots\ldots & \ldots\ldots & \ldots\ldots \\ p_{mo} & p_{m1} & \ldots\ldots p_{mj-1} H^m \frac{dN}{dt} & \ldots\ldots p_{mm} \end{vmatrix}}{|p_{ij}|}$$

where $p_{ij} = \frac{\gamma_j!\, N^{\gamma_j - i}}{(j-i)!}$ or 0 according as $j \geqq i$ or $j < i$, provided that N and all the $H^1\left(\frac{dN}{dt}\right)$ be known. This is by no means a hopeless task. The experimental curve of the growth gives N. Well-known graphical methods give $\frac{dN}{dt}$ and by the indicated combinations of these it is possible to obtain all the products of the operator H. These operations are then performed for as many points as are consistent with accuracy and convenience.

The result is that by straightforward and simple methods it is possible to follow the time changes in the vital coefficients, and therefore to support or disprove the theoretical interpretation that has been assigned to them. This in turn substantiates or vitiates the differential form (1) attempted.

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[2] M. F. Morales and N. W. Shock, *Bull. Math. Biophys.*, 4: 63, 1942.

[3] V. A. Kostitzin, "Mathematical Biology," George S. Harrap, London, 1939.

[4] M. F. Morales and F. L. Kreutzer, submitted.

TRANSLITERATION OF RUSSIAN NAMES AND WORDS

IN the course of the past months a number of notes appeared in SCIENCE in relation to transliteration of Russian names and words into English. The latest of these is that by C. S. Hoare (April 21 issue of SCIENCE).

I wish to point out that one factor appears to escape the discussion in most cases. It is simply this: Is the transliteration to be used for filing purposes and be independent of the language of the user, or is it to be a guide for writing the proper sound of the