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PRESIDENTIAL ADDRESS

THE "LOGARITHMIC PHASE" OF MEDICAL PROGRESS

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By custom the presiding officer of this society is expected to open the scientific session with a presidential address. This obligation, which I accept with grave misgivings, I shall try to fulfill in as short a time as possible, so that we may proceed promptly to the main program.

The thesis which I should like to present briefly, is that today we find ourselves in, or rapidly approaching, the "logarithmic phase" of medical progress.

The choice of my crude analogy is, of course, conditioned by my own past training and interests. Reference to the bacterial growth curve may be justified, however, on the grounds that it is familiar to nearly everyone in medicine (Figure 1). You will recall that the logarithm

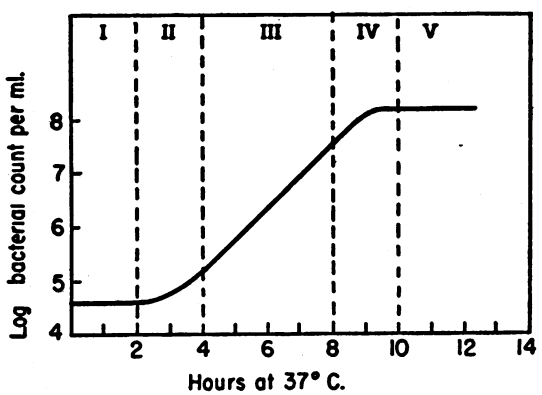

FIG. 1. CONVENTIONALIZED CURVE OF BACTERIAL GROWTH

of the number of viable organisms in a bacterial culture is customarily plotted on the vertical axis and the duration of incubation (in hours) on the horizontal. When cultural conditions are optimal, the curve exhibits five more or less separate phases of growth.

The first phase, usually referred to as the *lag phase,* is characterized by a stationary population. To consider it a latent period in the growth cycle is, as I shall explain in a moment, incorrect. The second period represents the transition from a stable population to one of rapid multiplication. The relatively gradual acceleration of multiplication in this *transitional period* is attributed to the failure of all of the cells to start multiplying at exactly the same moment. During the third phase of growth, the familiar *logarithmic phase,* all viable cells are presumably dividing at a maximum rate, causing the population of the culture to increase exponentially. Phases IV and V represent the final deceleration of growth, ending in a relatively stable population.

Today we need not consider the last two phases of the curve except to recall that premature cessation of bacterial growth may be caused by adverse cultural conditions, as well as by the addition of antimicrobial agents which interfere with the metabolism of dividing cells. The analogy here is obvious to anyone who has contemplated the possible effects on medical science of atomic warfare, of a sudden collapse or further disorganization of world economy, of an emphasis upon quantity instead of quality in medical education, of a sudden drying up of sources of research funds, or of a requirement for "responsible investigators" to prepare more progress reports than we are already required to do. Any one of these and a host of other unpleasant eventualities might cause a significant deceleration of medical progress even within our own lifetimes.

I should like to suggest that we turn our backs on these disturbing thoughts and return for a moment to the past, or, in other words, to the first phase of the growth curve. As I have already stated, the lag phase is not in reality a latent period. On the contrary, there is good evidence that individual cells in bacterial cultures are metabolically more active late in the lag phase than in any other phase of the cycle. This accelerated metabolism, unassociated with rapid cell division, causes two significant changes to take place in the culture. First, it results in an increased protoplasmic mass of individual cells; the oversized or giant organisms of the late lag phase are thus formed (Figure 2). Secondly, it brings about important alterations in the chemical environment of each organism—changes essential to the process of multiplication.

The counterparts of these two characteristics of the lag phase are not difficult to find in the early history of medicine. Viewed from our present vantage point on the steeply sloping curve of modern achievement, the era from Hippocrates to Claude Bernard may appear to have been a latent period, but, like the lag phase of bacterial growth, it teemed with ferment, particularly during its later decades. This ferment likewise gave rise to giants—Harvey, Leeuwenhoek, John Hunter, Lavoisier, and Liebig, to mention but a few. Like the oversized bacterial cells of the lag phase, these great figures of the past exerted a profound influence upon their environments, an influence which paved the way for the "logarithmic

phase" of scientific progress, in which we now find ourselves.

The century of medicine between Claude Bernard and the present was one of rapid acceleration, quite analogous to the steepening slope of phase II of the growth curve. Just as the oversized bacteria of the lag phase are replaced by the smaller rapidly dividing cells which characterize the logarithmic phase, so have the medical giants of the late nineteenth and early twentieth centuries given way to a host of well-trained scientists, educators, and physicians, individually of lesser stature but collectively of far greater potential. As the standards of medicine have risen, the prominence of the few has become relatively dwarfed by the accomplishments of the many.

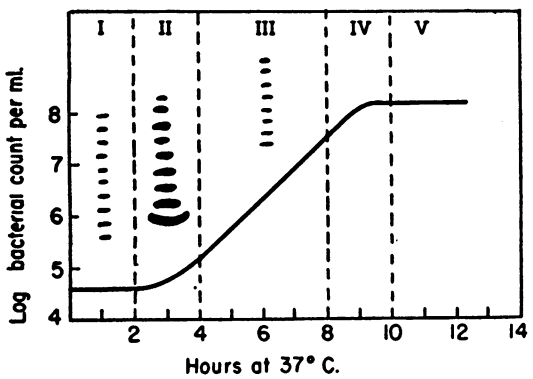

FIG. 2. DIAGRAM INDICATING CHANGES THAT OCCUR IN THE SIZE OF THE BACTERIAL CELLS DURING THE FIRST THREE PHASES OF THE GROWTH CURVE

Whether or not, in 1952, we have truly reached the "logarithmic phase" of medical progress may certainly be debated. It may be argued that progress will continue to accelerate for years or even decades before it enters an exponential phase. No one can deny, however, that the curve upon which we now find ourselves at the mid-century has a far steeper slope than that along which the founders of this society were moving more than forty years ago. The increase in slope has brought profound changes upon literally every phase of medicine. We would do well to examine briefly a few of their more striking effects upon us as physicians, teachers, and investigators.

First as physicians, engaged in the care of ill patients, we are keenly aware of our inability to keep abreast of even the most important advances in clinical medicine. When we scan the contents of medical journals, we are appalled by the volume of new information with which we should be familiar. To meet this problem, which every day is becoming more difficult, we have had only one recourse—namely, to specialize. No matter how much the trend toward specialization is decried by the Academy of General Practice, by medical economists, by educators, or by the lay public, it is here to stay, for it is an inevitable result of the steepness of the progress curve. The era when a single doctor could be an expert in all of medicine, or even in all of internal medicine, has long since passed. To bring to his patients the best that medicine has to offer, the physician of today must limit the scope of his practice to that field in which he is able to *remain* competently trained.[1] If his acquisition of new knowledge ends with his completion of formal schooling or his receipt of a certificate from a specialty board, he is doomed to an ignominious fate of professional obsolescence.

Secondly, the accelerated tempo of medical progress has affected medical education fully as much as it has influenced clinical practice. Only too well does the present generation of students and teachers realize that what is taught today may be outmoded tomorrow. The steepening curve of progress not only causes textbooks to become obsolete with discouraging promptness, but also renders senior faculty members prematurely senile in the eyes of their younger colleagues. Refined laboratory methods have increased the accuracy of present day diagnoses far beyond the dreams of the most skillful elders of the past. These precise diagnostic tools, as well as the numerous specific agents of modern therapy, require for their proper use a more intimate knowledge of chemistry, physics, and pathologic physiology than was ever before considered relevant to clinical medicine. So vast has this body of pertinent preclinical information become that no one teacher of medicine can possibly master it all. To meet the situation, he, like the practitioner, has been forced to resort to specialization.

Let us contrast for a moment a department of medicine of today with one of four or five decades ago. At the turn of the century teaching services were usually composed of a single professor, a resident, and a handful of house officers. The professor was met ceremoniously each morning at the front door by his resident and escorted to the wards for the daily round. There, followed by an attentive retinue of students and house officers, he passed final judgment on every manner of problem encountered at the bedside. Because of his vast experience in the management of patients, his opinions were rarely questioned, and his orders were followed to the letter.

How, I wonder, would such a versatile soloist of the clinic have viewed his counterpart of the mid-twentieth century? The modern professor of medicine, whatever else he may be, is certainly no soloist. To meet the requirements of progressive teaching, he has gathered about him a galaxy of highly trained colleagues, whose combined knowledge he hopes will cover the rapidly expanding fields of internal medicine. No longer a virtuoso, he has become the conductor of an orchestra composed of experts in an ever-increasing number of sub-

[1] By this statement I do not imply that internists should practice only subspecialties. Quite to the contrary, I believe that every physician should be broadly trained and should strive to maintain his competence in as much of general medicine as possible. At the same time, aware of his deficiencies, he should seek the aid of an expert consultant whenever his own ignorance may jeopardize the welfare of a patient.

specialties. Weekly at grand rounds, before an audience of students, house officers, and staff, he is expected to conduct a concert in which he displays the talents of his various experts by allowing them in turn to carry the melody. For any discord that results he is held personally responsible. In some respects, his assignment might frighten even Toscanini, for just as the orchestra is trained to perfection, one of its talented members will suddenly introduce a new instrument—a longer, more versatile catheter, an artificial kidney, another triumph of chemotherapy. With each innovation the professor is expected to become quickly familiar, for as conductor he must realize its possibilities and limitations, in order to integrate it with the rest of the orchestra. Judging from my own brief experience in this exacting role, I wonder if the average professor of medicine today ever really "knows the score."

Finally, the character of medical research has been changed by the rapidity of scientific advance. As the body of knowledge available to medical investigators has increased, so has the need for specialization in research become mandatory. Team projects are the fashion of the day. To be sure, many problems can be solved only by collaboration of experts from a variety of fields. But as every scientist knows, ideas come from individuals, not from groups or institutes. Again the giants of the recent past—Claude Bernard, Pasteur, Emil Fischer, and Ehrlich, each of whose contributions to medical science cover a wide range of subjects—have been succeeded by men whose research has perforce been limited to a lesser scope. Today, more than ever before, individual workers must concentrate their efforts on a single, relatively narrow field, in order to contribute significantly to medical knowledge. To dig deeply at the frontiers of modern medicine requires decades rather than days, the whole life of the investigator rather than the term of his research grant.

To its medical scientists, contemporary society has been most generous. Well has it heeded the advice of Pasteur: "Take interest, I implore you, in those sacred dwellings which one designates by the expressive term, laboratories. Demand that they be multiplied, that they be adorned. These are the temples of the future."

The scientific program, which we are about to hear, and the large number of equally excellent reports which I was forced to omit from the final program, provide convincing evidence that the clinical investigator of today, in spite of daily distractions of practice, teaching, and administration, is making good use of his laboratories. The variety and content of the individual papers will, I am sure, eloquently support the general thesis that the slope of the medical progress curve as of 1952 is indeed steep.