cieties. In any event, rapid changes in behavior are demanded of the person at all levels of social organization even when the society is at its most stable. Life at any level of social development in human societies is a pretty complex business, and it is met and handled most efficiently by those who exhibit the greatest capacity for adaptability, plasticity.

It is this very plasticity of his mental traits which confers upon man the unique position which he occupies in the animal kingdom. Its acquisition freed him from the constraint of a limited range of biologically predetermined responses. He became capable of acting in a more or less regulative manner upon his physical environment instead of being largely regulated by it. The process of natural selection in all climes and at all times have favored genotypes which permit greater and greater educability and plasticity of mental traits under the influence of the uniquely social environments to which man has been continuously exposed.

The effect of natural selection in man has probably been to render genotypic differences in personality traits, as between individuals and particularly as between races, relatively unimportant compared to their phenotypic plasticity. Instead of having his responses genetically fixed as in other animal species, man is a species that invents its own responses, and it is out of this unique ability to invent, to improvise, his responses that his cultures are born.

The Problems of Gerontology

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WITHIN RECENT DECADES THE specialty of pediatrics has developed out of the general field of medicine, and with this specialization progress in promotion of the welfare of children has been largely accelerated. It is rather remarkable that until lately the opposite stretch of the life span has remained a largely neglected field of interest. There is abundant reason to believe that comparably focalized interest in the problems of aging will yield much of profit not only to the elderly themselves but also to society at large. All the various approaches to this problem are incorporated in the science of gerontology.

Generally speaking, the methodology of gerontological research amounts simply to contrasting the youthful and the aging organisms with respect to their various biological characteristics. By the introduction of this comparative feature, almost any research in any field of biology, from that of biochemistry to that of sociology, can be made, in effect, a research in gerontology. This is equally true whether the given research is addressed to description or to experimentation. An important aspect of investigative gerontology is therapeutic research. Thanks to the fact that large aggregations of elderly persons are available in different sorts of eleemosynary institutions, it is possible to set up this type of study with more adequate controls than are possible in many other sorts of therapeutic research.

At the *molecular level* of integration[1] many studies are needed. A few sorts of these may be particularized. One functionally important class of molecules is the amino acids. In view of the special influences of various of these on the processes of cell differentiation and maturation, significant correlations might be found between amino-acid metabolism and acceleration or retardation of the aging processes as well as the biological efficiency of the organism at any given age. Various other metabolically important molecules, such as cholesterol and folic acid, also demand consideration.

Much remains to be elucidated about the different internal secretions. The two major problems in this part of the field involve determination, at various ages, of the levels of production of the several hormones and the reactivity of the body to each. What is partly known regarding the influences of the gonadal, the thyroid, the adrenal, and the anterior pituitary hormones on maturation processes renders further studies along this line imperative. A chief methodological need is to bring to bear the latest advances in the field of physical chemistry in the hope of deriving technics for the quantitative appraisal of the titers of each of the hormones in the circulating blood. Until this is accomplished we shall have to continue to limp along, deriving such information as is possible from studies of urinary excretion of the hormones or their end metabolites. Generally speaking, the entire endocrinology of the senescent and senile periods is in need of further study.

An equally persuasive case can be made for a study of the different vitamins in relation to the aging processes and to the various organic functions in postmature individuals. A modicum of information is

[1] For a recent discussion of the concepts of integrative evolution, see Novikoff (*3*). A discussion of the applicability of the concepts to a larger biological problem has been offered by the writer (*2*).

available indicating that anomalies of vitamin assimilation and metabolism are characteristic of the aged, but much more particularized knowledge of each of these controlling agents is needed in relation to both health and disease. The functional interrelations of the vitamins with each other and with the hormones demand further study.

Perhaps more important than any of these other specialized molecules are the enzymes by which cellular chemistry is so largely regulated. Both the formation of, and reactions to, the hormones are seemingly matters largely of special enzyme metabolism. Presumably, the enzymes play an equally important role in vitamin metabolism. Underlying many of the pathological processes as they become visibly manifested in cells and organs are, no doubt, perturbations of enzyme factors in metabolism. Many years of searching investigation of the enzyme physiology and pathology of senescence are obviously needed.

A major aspect of all the above-mentioned problems is a determination of the extent to which the various anomalies and their consequences in form and function are reversible at the various age periods. A special facet of this problem is the therapeutic possibilities of these various agents for retardation or amelioration of senescence.

Turning to manifestations at the *cellular level*, we find that these are to a considerable extent obvious consequences of phenomenology at the molecular level. There are, however, important aspects of cell biology that cannot be studied in terms of immediate chemistry. In general, these include the form, size, structure, differentiation, and integrity of cells. It is at this level that much of the phenomenology of pathology as now visualized appears. The aspects of cellular pathology that are most obviously important to gerontology are neoplastic growths and degenerative changes in the various tissues. The need for the development of a more adequate functional cytology is evident. In various ways the microchemistry of the cells already lends itself to study, and other methods no doubt will appear as the resources of the newer physical chemistry are brought to bear. The recent work of Dempsey and his colleagues seems especially promising to this end. These latter approaches seem, on the whole, more promising for the elucidation of cellular physiology and pathology than does electron microscopy. The influences of imposed variations in hormone, vitamin, and enzyme factors on cytology—and especially functional cytology—offer scope for many investigations in this field.

At the *organ-function* level of emergence appear the architecture and the activities of the organs and organ systems, *as such*. Generally speaking, productive studies at this level require different concepts and technics than at the metabolic or cellular level. Most of the so-called "vital-function" tests pertain to this level, e.g. "gastric-acidity," "renal-function," or "liver-function" tests; and it is also at this level that the principles of homeostasis as elucidated by Cannon largely operate. Phenomena at this level make up a large part of the subject matter of geriatrics as now visualized. Numerous of the most obvious problems of gerontology consist of comparisons of elderly and younger individuals with respect to organ efficiency and of therapeutic measures to improve such efficiency. The problem of promoting longevity is customarily studied chiefly at this level, although studies at the molecular level might actually be more productive.

At the *simple behavioral level* we first have to deal with the "organism as a whole." At this level such manifestations as maze learning, breeding patterns, nest building, and various sorts of still more primitive behavior come to attention. This category of activities is a matter of much interest in comparative biology, but in the case of human beings the phenomenology can profitably be studied for the most part in connection with those of the next higher level, the psychological or ego-oriented.

At the *psychological level* appear those many biological manifestations in which the neopallium plays an important or dominant role and in which "reactions in consciousness" are the matters of central interest. Much of the existing knowledge of activities at this level is conceptualized in terms of ego function. Here we deal with that vast array of items that make up the subject matter of psychology and psychiatry as organized disciplines, and here many of the most important problems of gerontology arise. It is the operation of factors at this level that largely determines whether longevity promoted at lower levels is actually worth the while of the individual himself.

In this necessarily brief discussion adequate presentation of the psychology of senescence is impossible. The place of psychology in the total over-all problems of gerontology can, however, be indicated. Many of the older technics can still be utilized and, as newer technics appear, these too can be applied to the elucidation of the differential characteristics of the aging.

Obviously, the chief desiderata in the later years are a sense of physical well-being and feelings of interest and contentment. The possibilities of psychotherapy for the aging center largely in the last-mentioned item. Individual therapeutic efforts and organized projects addressed to individual psychological welfare are most productively based on a consideration of the fundamental human drives as these have been derived through the long course of evolution. The relative potencies of the drives can be appraised in accordance with their operational significance in promoting individual or group survival.

Throughout the evolutionary period superiority has been a necessity for survival. This necessity is rep-

resented subjectively by the sense of self-esteem. A primary requisite to individual contentment, then, is the preservation of a tolerable degree of self-esteem.

The need for a sense of security is likewise of obvious importance and can be dealt with to some degree at the psychological level—but the problems are rather more social and economic. A sense of insecurity is a chief cause of anxiety, which not only deprives the individual of contentment but likewise leads to numerous perturbations at the physiological level. Since these latter are often life shortening, a part of the actual problem of longevity lies at the psychological level. Anxiety, as such, can be controlled in a measure by psychotherapy. Some of the simpler means to this end have been discussed elsewhere (*1*).

As to other possibilities for research at this level, only one further hint will be offered. Most of the drives that have to be considered are those addressed to individual survival. The gregarious pattern of living which our ancestors evolved is implemented to a considerable extent by another set of drives—those addressed to group survival. A major factor here is the sense of group solidarity; at the individual conscious-emotional level, this "sense" may be designated as "empathy" (*2*). A lively degree of empathy is a requisite to inner health and hence to contentment.

The upper limit to which the processes of integrative evolution have carried our species is the *social level*, and it is at this level that some of the most important problems of gerontology are presented. Issues of large moment hang on the fact that the modal citizen is constantly becoming an older person. Many social and especially economic adjustments to that fact are increasingly demanding attention. Not only, of course, is the welfare of the aged involved but that of the younger groups as well. The need for the development of more adequate technics for research at the social level is obvious—indeed, our survival as a species is involved.

The central problems of gerontology at this level are those of adapting the aging individual to the changing society and of evolving social patterns in which the values of the older individuals can most adequately be utilized. The impressive work of Lawton in New York is showing with increasing clarity how studies at this level can yield much in the way of enhancing the contentment of the elderly. Perhaps equally important to this end are the studies of Ford and others on the possibilities of utilizing the older workmen in industry.

Belatedly, several specialized agencies are now in process of development for the promotion of gerontology. Geriatrics, having to do with diseases of the elderly, has its recently organized society and its journal, *Geriatrics*. Less than a year ago a broader approach was visualized in the organization of the Gerontological Society, Inc., and the founding of the *Journal of Gerontology*. This Society and its journal propose to deal with the problems of aging from all the relevant and significant points of view. It is expected to enlist the cooperation and support not only of physicians but of other serious students, such as biologists, physiologists, pathologists, psychologists, sociologists, economists, and administrators—in short, of all who are contributing actively to the solution of the problems of aging. During the first year of its existence the Gerontological Society has been engaged primarily in the building up of a strong and representative body of charter members. Information regarding this organization can be obtained from the secretary, Dr. Henry S. Simms, 630 West 168th Street, New York 32, New York. Applications for membership are welcome.

A still more recent development is the setting up of a Gerontology Study Section in the Research Grants Division of the National Institute of Health (*4*). Under the chairmanship of Dr. Henry S. Simms, Columbia University Medical Center, and the secretaryship of Dr. Nathan W. Shock, National Institute of Health, Bethesda, Maryland, this Section proposes to take an aggressive and constructive part in promoting progress in its field. The Federal law under which the Research Grants Division operates permits much freedom of action both to the Section and to cooperating investigators. Especially noteworthy are the thoughtful provisions that have been set up to insure freedom of action and responsibility of the immediate proponents. It is presumed that adequate funds will be available for the support of any sound projects that may be offered or devised by the Section itself. Another provision of major promise for advancement over the longer period is for generously-funded training fellowships. In short, at long last, the way is broadly opened for the support and encouragement of researches of any and all sorts for the welfare and social utilization of the aging members of society.

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