



HEREDITY AND ENVIRONMENT
FROM THE MEDICAL VIEWPOINT

BY
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Address by invitation at the annual meeting of the Sphex Club,
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Though we are admonished to avoid in ordinary conversation the talking of "shop," I am convinced that on occasions of this kind a speaker cannot do better than to talk regarding his own particular "shop." For if he can interest an audience at all, he will do so by discussing some of the problems that are constantly confronting him in his own work, about which he thinks much and feels deeply. My own life, as some of you know, has been devoted in the main to the teaching and practice of medicine. In this work, one is compelled to consider daily the bodies and minds of human beings of different ages. He has to investigate carefully the structure and functions of these bodies and minds in order to discover in what way, if any, they deviate from what we call the "normal." When abnormalities are found, he must attempt to bring about readjustments that are the best possible in the circumstances. In the prosecution of such work, the conscientious medical practitioner strives to determine in each case the relative significance of constitutional make-up on the one hand, and of environmental influences upon the other.

Compelled to study a great variety of persons, the medical man becomes intensely interested in all the problems that bear upon the development of the human individual. Confronted in his consulting room by a given person who seeks his help, he is fascinated by the problem of discriminating between the factors of inheritance and the factors in the surroundings of what is inherited, for upon the interaction of these, he believes, the genesis of the realized person before him must have depended. In other words, to understand the people whom he is trying to help he must inquire into both their "nature" and their "nurture," for only through such inquiry can a just appreciation of the

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form and behavior of a given person be gained. You will understand, then, why I have chosen as a topic upon which to speak to you tonight, "The Influence of Heredity and Environment on Man from the Medical Viewpoint."

EXTERNAL AND INTERNAL FACTORS AND DISEASE

Those who are acquainted with the history of medicine know that the interest of medical men in their studies of the origin of disease has at certain periods been directed more to external causes and at other periods more to internal causes. At times, it has been the environment of men changing their condition that has attracted especial attention. At other times it has been the hereditary make-up of patients, their "constitutions," that has been the object of special research. The pendulum has swung to and fro, the swing corresponding as a rule to changes of direction in general biological research. The better medical practitioners, however, especially those of a philosophical turn, have kept ever in mind the two sets of factors, hereditary and environmental, even though temporarily they have directed their researches more in one direction than in the other. In general, they have looked for what they call the "exciting" causes of diseases in influences arising outside their patients, and for what they call the "predisposing" causes of diseases in influences residing within the patients themselves, the latter in turn depending partly upon inherited tendencies, partly upon environmental influences exerted earlier in life. Thus, sometimes, too much attention has been paid to predisposition to disease, at other times too little. A notable example may be seen in the history of the discovery of the skin disease known as *scabies* or what is ordinarily called "the itch." Although the itch insect had been known for a long time and one medical man had already produced the disease experimentally in one of his friends by placing the itch insect upon him, it was not until more than fifty years later that the medical profession could be convinced that itch was due to a parasitic invasion from without, for physicians held fast to the belief that itch depended upon a peculiar disturbance of the humors of the body that they spoke of as the "itch dyscrasia." At about the same time, it was found that a certain disease of the scalp known as *favus* was due to infection from without by a peculiar fungus. It is interesting that it was students of diseases of the skin who first discovered that animal and vegetable parasites from the surroundings

could be the cause of disease in man. A half century later, through the rise of modern bacteriology and protozoölogy it was found that a host of human diseases are due to infection from without by minute vegetable microörganisms (micrococci, bacilli) or to invasion from without by microscopic animal parasites (such as the parasites of malaria, the trypanosomes of sleeping sickness, or the spirochetes of syphilis).

EMPHASIS ON EXTERNAL FACTORS

During the last half century, medical research has quite naturally been predominantly directed toward these external causes of disease, to the discovery of animal and vegetable parasites, and to those harmful influences in man's surroundings that lower his resistance to bacterial infection and to parasitic invasion. Investigators have found the germs that cause sepsis, typhoid fever, dysentery, tuberculosis, syphilis, leprosy, diphtheria, pneumonia, malaria and a host of other diseases. They have found how the germs enter the organism, some of them through contaminated food, some through polluted water, some through abrasions of the skin or mucous membranes, some through the bites of insects. As a result of such discoveries, it is now possible in large measure, to prevent the occurrence of many of these diseases. Typhoid fever is disappearing as cities and towns are making provision for supplies of pure water. The prevention of yellow fever by an anti-mosquito campaign permitted the digging of the Panama Canal. Human health and efficiency are being promoted in the Southern states and in Porto Rico by the prevention of hook-worm invasion. The ravages of syphilis are being averted partly by education regarding prevention, partly by killing the spirochetes that cause it by injecting salvarsan into the blood or the cerebrospinal fluid of the infected. Obviously, medical research and medical practice have scored noteworthy triumphs as a result of the attention paid to these environmental causes of disease.

EMPHASIS ON INTERNAL FACTORS

But the success attendant upon these studies of disease-causing influences in the environment temporarily distracted attention, perhaps unduly, from the internal factors that play a rôle in favoring or preventing the development of disease processes. It was not long,

however, before investigators were compelled to return to the study also of manifest differences in susceptibility to attack by various external agents and of the obvious variability in rapidity and completeness of recovery exhibited by different persons. Why does one child exposed to diphtheria sicken and another remain well? Why does John Doe, though a moderate drinker, develop hardening of the liver, while Richard Roe, who drinks three times as much escapes? Why do several brothers and sisters in one family develop tuberculosis of the lungs while those of a neighboring family, even with poorer food and greater hardship, are immune from it? Why are there many suicides in one family and none in another? Why of two sleepers in the same bed room is one bitten badly by mosquitoes, or by bed-bugs, while his fellow is less disturbed? Obviously there are great differences in the "insides" of the persons upon which external agents act. Physicians are forced therefore to take into account what they call "differences in disposition to disease" and to try to determine in how far disposition is inherited and in how far it is acquired. Human beings resemble one another but each differs from every other. Each person is unique. How does a given person, so like others and yet so different from others, come to be what he is?

THE DEVELOPMENT OF A HUMAN INDIVIDUAL

Biologists, busy during the last century under Darwin's leadership with the investigation of the origin of species and with considerations of the doctrine of evolution, have in our time turned their attention more particularly to the study of the origin of individuals, engaging actively in observation and experiment bearing upon the phenomena of inheritance and development. Just a century ago, two men who were destined to revolutionize our ideas of heredity were born in the same year. One of them, Gregor Mendel, an Austrian monk of humble origin, worked in the garden of his cloister on the effects of hybridization of peas. The other, Frances Galton, a scion of an aristocratic English family, explored wild countries, studied meteorology, anthropology and psychology, applied mathematical methods to biological problems, became tremendously interested in the relations of heredity to genius and to crime, and foresaw "possibilities of the improvement of human stocks under present conditions of law and sentiment," thus originating the modern eugenic movement, which attempts to get people "well-born." During the past few decades,

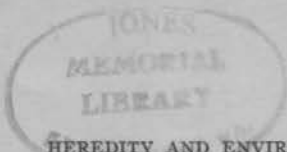
great progress has been made in our knowledge of the development of individuals through (1) the experimental breeding of plants and animals, (2) the study of germ-cells, of the process of fertilization, and of the growth and differentiation of young organisms by cytologists and embryologists, and (3) the application of mathematical methods to the determination of relations among the phenomena under study. A useful epitome of the results of the studies is to be found in Professor Conklin's admirable volume *Heredity and Environment in the Development of Men*. I can recommend its perusal by laymen since it is written in language that is simple and clear.

Knowledge has been so far advanced that we can safely assert that human beings develop according to laws that are essentially the same as those that hold for inheritance and differentiation among plants and animals. Man, like the chicken or the rabbit, begins through the union of two sex-cells, an egg-cell (ovum) from the mother and a fertilizing cell (spermatozoon) from the father. These two cells, fused to form a single cell, start a new individual, which in a suitable environment, subdivides into two cells, then into four, and then gradually into many millions of cells. This new individual develops stage by stage, first as an embryo within the mother's womb, later as a child within the home, still later as a boy or girl in the school, and finally reaches adulthood, entering into manifold relationships with the larger world of society. In these successive stages of human development and differentiation, we have to deal with two sets of factors (1) those of the germ plasm derived from the father and mother (factors of heredity), and (2) those of the surroundings of the developing being (factors of environment). The factors of heredity offer certain possibilities of development (and no others); among these possibilities of development, those actually come to fruition that are brought there through the influences of the factors of the environment (physical, chemical, psychical and social). As the medical man sees his patient, he looks upon him as the resultant of a long series of interactions between an ever-changing environment, on the one hand, and an organism that begins as a fusion of two germ cells and gradually becomes an adult person, on the other. The heredity of the patient has determined the *possibilities* of his development; the surroundings during development have been decisive as to the possibilities that have attained to *realization*. The physician believes that a super-scientist who could know all the details of the

factors of inheritance and all the details of the factors of environment, as well as what would happen when the internal and external factors react with one another, would be able to predict the form and functions of a given individual, and could account accurately for his knowing, his feeling and his striving; in other words, he could explain his intellect and his character, and could prophecy what his behavior would be in a given set of circumstances.

INTERNAL SECRETION, AND HUMAN DEVELOPMENT

An interesting example of the way in which our newer knowledge of the genesis of the human individual is throwing light upon the forms and functions of the patients that a physician sees is to be met with in the domain of the internal secretions. It is now known that there are certain glands in the body, which are known as endocrine organs, and whose functions are of the first importance, not only for changes in the structure of the body during its development, but also for the way in which the functions of the body are performed during every-day life. Among these glands are the thyroid, the pituitary, the suprarenal, the pancreas, and the sex glands. The stature of a person, his weight, the texture of his skin, the distribution of the hairs on his body, the shape of his bones, the frequency of his heart beat and the energy manifested in his activities, seem to a large extent to be dependent upon the effects of the chemical substances produced by these glands. Thus, a person who, during development, has had an over-active pituitary gland, may become a giant, whereas one who has had an under-active pituitary gland, may become a short, fat individual with imperfect sex organs. Again, should the thyroid become markedly over-active, the patient's eye-balls will protrude; his heart will beat, say 120 times per minute instead of 70 times; his fingers will tremble; he will sweat profusely and he will lose weight rapidly; whereas should the thyroid become markedly under-active, he will grow fat and stupid, his skin will become thick and wrinkled, and his hair will fall out. Or, still again, if the internal secretions of the pancreas fail to be produced, the patient will be a diabetic, large quantities of sugar will appear in his urine, and he will complain of an intolerable thirst. The patient with over-active thyroid gland will often be much benefited by surgical removal of a part of that gland, whereas the patient with too little thyroid activity can often be benefited by feeding him the dried thyroid



gland of the sheep. Severe diabetic patients who do not respond to treatment by diet alone can to-day be made to utilize sugar by injecting under the skin a substance called *insulin*, which is the internal secretion of the pancreas derived from animal tissues.

EUTHENICS

If the human individual is the direct resultant of the interaction of factors of heredity with factors of environment, it is clear that in the treatment of a given patient the physician, in making use of remedial measures, is limited to the application of favorable environmental influences. For if the patient's heredity cannot be altered, all that the physician can do is to bring to bear upon the "realized person" influences from the outside that will be of benefit to him. Through the use of physical, chemical, psychical and social influences, he must do his best to change the patient so that his body and mind may make better adaptations to the situations in which he finds himself. Thus physicians make use of diet, of rest, of exercise, of baths, of drugs, of occupation, and of psychical and social influences in their efforts to restore their patients to what is called health. The science that deals with the improvement of environmental influences for the welfare of man has been called *euthenics*.

EUGENICS

Though the human beings already born have their heredity unalterably fixed, the factors of inheritance of those that are to be born will be determined by the character of the germ plasms that fuse at their start. The question then arises, in how far is it possible to realize the vision of Frances Galton, who foresaw an improvement in hereditary stocks through education, and perhaps legislation, influencing and partly controlling germ-plasm fusion? This eugenic problem is one of the most difficult and perplexing of the many problems that confront our race. Our experience with certain physical diseases, with insanity, with mental deficiency and with crime, convinces us of the significance and dangers of the transmission of inferior germ plasms, in other words, of hereditary factors that are faulty. It has even been suggested as possible that the activities of doctors and of our great public health agencies, in prolonging the lives of the weak and the biologically unfit, are contributing to the deterioration of our race by permitting an increase of transmission to succeeding genera-

tions of inherited qualities that are inferior. Can anything be done in the way of arranging for the greater encouragement of parenthood by the more fit, for the discouragement of parenthood by the less fit, and for the prohibition of parenthood by the notoriously unfit, while we, at the same time, prolong the lives of the biologically less fit and of the wholly unfit through environmental improvement? Unless something definite can be accomplished in this direction is it not possible that the inborn capacities of man may undergo progressive deterioration and contribute to ultimate race extinction? Now that we are becoming familiar with Nature's laws, can we not learn how better to cooperate with nature and improve our race rather than do injury to it? But we shall accomplish more, I feel sure, by education than by any premature legislation.

We can see the problems, but their solution will not be an easy matter. Certainly as yet it would be a brave man who would decide in every case regarding the fitness to survive, even though he might be in no doubt as to a decision that certain manifestly unfit persons should be denied the privilege of parenthood. The world needs many varieties and degrees of inborn capacities in its human individuals. It is conceivable that the breeding of people who were nearly alike, even if superior in type, might be less advantageous to human society as a whole than the breeding of races in which hereditary capacities exist in greater varieties than those now existent. Students of human nature have differed in their opinions as to its alterability, either by conscious control of heredity, or by educational or institutional changes. There are optimists who believe in the infinite perfectibility of mankind. There are pessimists, as you know, who assert the practical unalterability of human nature.

The medical mind with a knowledge of evolution (as studied by the biologists), and of human customs and institutions (as studied by the sociologists) is inclined to believe in the idea of the possibility of progress notwithstanding the fact that this idea has been challenged by some of the world's greatest thinkers. For, despite the fact that hereditary transmission by germ plasms is similar in man to that in other animals, there is a marked difference in the traits that exist at birth. In man the mental equipment is less definite, less fixed, more vague and more plastic than in animals. The chick when hatched can feed itself, can run about, and very quickly become independent of the mother hen. The human infant cannot walk until it is about a

year old, and requires many years of teaching to secure an independent living. The plasticity of the developing human being, his teachability, makes possible the greater variety of adaptation of his later life. If, in the processes of evolution, human heredity has already reached a stage of advantage so far in advance of that in animals, is it not possible that many aeons hence there may be a great gap of advantage between the hereditary qualities of the child of that future and those of the child of to-day?

Or, even if hereditary qualities should in the future undergo but little change, is it not possible that human habits, human customs and institutions may become so altered, prevailing types of thought and desire become so changed, that human life as a whole may become fuller, richer and more beautiful than it is to-day? I myself am one of those who still harbor the idea of progress. I cherish the hope that, gradually, great reforms will be brought about through the extension of our knowledge of the possibilities of human intercourse, through the steady devising of new social inventions, and through the study of, and persistent experiment in, social engineering. Sometime in the far distant future our race may discover even what William James visualized, the moral equivalents of war. Sometime, too, human beings may work out some satisfactory substitute for the faulty economic regime that now exists. Dreams as these are yet their realization would not be less astounding than the actual fulfillments that we have seen in our times of the visions of dreamers of the past. But if in the future there ever come to realization the visions of the seers of to-day, it will be through a long accumulation of new knowledge obtained by application of the methods that scientific investigators have taught us to employ. And, from the physician's viewpoint, it would seem probable that the greatest progress in human welfare in the future will depend upon the discoveries to be made in the mechanisms of human inheritance and in the interactions between developing human beings and their environment.