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HEREDITY

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One of the greatest problems that has concerned the thought of scientific men is that of individual development; and coupled with this is the problem of the analysis of those factors involved in the transmission of racial characters from one generation to the next. It has been the observation of men for ages past that "like produces like." The egg of a fish is more likely to develop into a fish than a frog, although the two bits of protoplasm may greatly resemble each other and their environments be identical. Fundamentally resident within each living mass are determining factors that shall say what the ensuing development shall be under certain environmental conditions. A given environmental stimulus may completely upset any intrinsic mechanism so that a divergent development may ensue; but given an environment normal for a particular ovum and a certain development invariably ensues. Nevertheless, we do not expect identical developments even under such conditions: a variation in any characteristic is more normal a behavior than is complete identity. Thus we may say that heredity is the condition which is maintained by a certain balance between the operation of intrinsic conditions in a given protoplasmic organization and the external conditions within which it is placed.

An individual is the sum total of the characters that comprise it; and upon analysis it is evident that each character bears a greater or a smaller degree of resemblance to that particular character of a parent. When a particular unit character is regarded as of germinal origin it is said to be inherited, while that due solely to subsequent environmental impetus is regarded as acquired. Racial characters, such as may pertain to the race, *the genus and species of an individual, are of course inherited. Individual* characters such as pertain to the general morphological features as well as to certain physiological peculiarities are known to be functions of the germ cell. Pathological peculiarities, such as polydactylism, myopia, coloboma, etc., are definitely inherited; while of course many monstrosities are but acquired defects due to certain environmental stimuli. Furthermore, psychological characters appear to be inherited in the same way for general aptitude, temperament, affection and disposition run in families. There is no longer a question but what feebleмindedness, epilepsy and insanity have their basis in an unstable germ plasm.

It is the purpose of this paper to inquire briefly into certain of the fundamental laws of inheritance, their application and extent; and thence to examine cytologically for evidence of the mechanism that is instrumental in the process.

Any study of heredity must of necessity involve an analysis of its subject into its constituent unit characters. When these are known to be pure, individuals with one pair of contrasting characters may be crossed and the results noted. In such a cross, all individual offspring show only one of the two contrasting characters. If these individuals are then self-fertilized, the second filial generation will include certain individuals which

possess one of the contrasting pair of characters and certain individuals which possess the other unit character, the ratio of the numbers in the two groups being approximately three to one. A concrete case will serve to illustrate this law. If a tall pea is crossed to a dwarf pea, the offspring are all tall; thus the factor for tallness in the germ cell is dominant to that for dwarfness. If these tall peas are now bred their offspring are tall and dwarf—as their grandparents, in the ratio of three tall individuals to one dwarf. In succeeding generations it is found that the dwarf pea produces only dwarf plants; while one-third of the tall produce only tall plants and two-thirds produce both dwarf and tall plants in the ratio of three to one. It appears evident that two kinds of germ cells must be produced and that each germ cell is pure for one of the contrasting pairs of characters. When an ovule possessed of the factor for dwarfness is fertilized by a pollen grain with the factor for tallness, only a tall plant may result since tallness is found to be dominant to dwarfness. When certain characters of any conjugating pair are exactly alike, the individual resulting from the cross is said to be homozygous; and when these are unlike it is said to be heterozygous for that particular unit character. Thus the first law of Mendelian inheritance is the separation and the segregation of the factors for any given character in the germ cell; so that any germ cell is pure for but one of a contrasting pair of characters.

When given individuals differ from each other in two pairs of characters, it appears that such a cross results in the normal three to one ratio and that the inheritance of one pair of characters is independent of that of the other. Thus when a plant possessed of round, yellow seeds is fertilized by the pollen grain of a plant with green wrinkled seeds, the seeds of the first filial generation are yellow and round since yellowness and roundness prove to be dominant. When these seeds are grown and self-*fertilized, the results of the second filial generation show nine yellow round,* three yellow wrinkled, three green round and one green wrinkled. Taking each individual character by itself, it appears that the normal Mendelian ratio is undisturbed by the presence of any other unit character; and that *the distribution of the members of one pair of factors in the germ cells* must be independent of the distribution of the members of any other pair. This independent assortment of the factors, or genes as they may be called, is found to maintain for dihybrid, trihybrid and polyhybrid crosses.

It must be accepted that characters as such do not exist in the germ cells; but that for each adult inherited character there must be some differential inciting cause in the germ plasm. Each hereditary character must be induced by some particular inheritance determiner or combination of determiners in the germ cell or zygote. Color, e. g., is a character that appears to depend upon the presence of at least two such determiners; namely, a factor for pigment together with a factor for color developer.

The principle of dominance is not without modification, for in a large *number of cases it appears that dominance is incomplete or imperfect.* This is found to be true in many varieties of flowers, in certain fowls as well as numerous mammals. To illustrate the principle it is found that when red and white cattle are crossed, the offspring are roan, a chestnut

brown; but the second filial generation gives a ration of 1:2:1 in which one-fourth are red, one-half are roan and one-fourth are white. The roan individuals are heterozygotes in which the red is only incompletely dominant over the white, while the red and white individuals are pure homozygotes.

Numerous studies upon the appearance and absence of certain human traits have been made; but these must always be more or less unsatisfactory. The *normal Mendelian expectancy cannot with assurance be predicted*; because the human mechanism is not pure for any particular character, but is rather a complicated mixture of many lines. Experimental procedure is obviously impossible, and the relative number of offspring per family is too small to determine what the entire results of any one cross might be. The observational and statistical method, however, have been employed to a very large extent and numerous human traits are now known to follow the usual Mendelian ratio.

With this brief statement as to the fundamental principles of Mendelian inheritance, it will be well to enquire into the nature of the germ cell itself and the mechanism involved in the fact of inheritance. The living body is composed of two kinds of cells, known as the soma or tissue cell and the germ or the reproductive cell. The concept of germinal continuity from one generation to the next has long been regarded as an established fact; although recent studies would appear to show that germ cells are but specialized parts of the embryonic soma as any other normal tissue is known to be. However, aside from their origin, these two kinds of cells are present in each normal individual; and, for a considerable period of time, the two are exactly alike in their nuclear contents. As development ensues, while the soma becomes more extensive and differentiation occurs, the potential germ cells merely increase in number, passing through what is known as a multiplication period. In addition, before a germ cell becomes *functional, it must pass through a maturation process* when its nuclear content becomes reorganized and subsequently reduced in amount. It is during this period that factors for particular characters are shifted and sorted, so that an understanding of the procedure is essential to a grasp of the method of inheritance.

An immature reproductive cell is usually larger than any soma cell; although their nuclear contents are identical, since they arose by repeated mitoses from a single fertilized egg cell. Each immature ovum consists of two principle parts, an external, somewhat semi-fluid substance known as cytoplasm, which is concerned with the vegetative functions of perception and movement; and the idioplasm or nuclear substance concerned primarily with reproduction and thus with inheritance. Within the nucleus is the chromatin, which is not a homogeneous substance as originally supposed, but is made up of discrete differentiated structures, known as chromomeres, each with a specific function, the bearer of the heritage. These appear as more or less regular spherules arranged in a definite position in the nucleus of each succeeding cellular organization. The maturing of the ovum involves two rather rapid mitotic divisions, so that from a single primordial ovum, four functional germ cells arise. During the maturation the

chromomeres of the nucleus concentrate, become more compressed, and form more or less definitely organized structures known as chromosomes. Since all the cells of an organism arise from a single fertilized ovum, they all possess a similar series of chromosomes, characteristic not only for the individual but for the race of which it is a part. Chromosomes are definite in number, shape and position for any given cell.

In a study of a single group of chromosomes entering upon the maturation process, it appears that they come to be arranged in pairs; and that each pair comprises chromosomes and chromomeres of more or less identity. These homologous pairs are derived from opposite parents, but possess factors for the development of the same structure. Thus it is evident that each primordial germ cell contains two sets of determiners, either one of which would be sufficient for the development of the individual. During synapsis, as this conjugation of chromosomes is called, homologous chromomeres lie opposed to each other. Soon, however, they separate in such a way that the cell division which ensues gives each daughter cell one of each pair of the conjugants. By way of illustration, if there are forty-eight chromosomes in the human primordial ovum, there will be twenty-four synaptic pairs at the time of maturation. One of each synaptic pair is a derivative of the father, while the other is of maternal origin; *both will bear the factor for the development of some particular* character, but, due to the principle of dominance, only one character usually appears. These conjugating pairs soon separate and twenty-four chromosomes will form the nucleus of one mature ovum; while the other twenty-four chromosomes unite to form the nucleus of another ovum. With this procedure in mind, it is clear that certain mature human ova may contain the twenty-four chromosomes all of one parental origin; or certain of them may be of paternal origin and the others of the mother. Thus great variety may obtain in the chromosomal complex of any mature human ovum; and since each chromosome is composed of smaller units, the chromomeres, which bear the heritage factors, it is easy to see how such infinite variety in adult characters maintains.

With the thought of the chromosomal synaptic relations in mind, it is easy to see how the normal Mendelian ratio obtains. In the case of the pure black guinea pig, there are two chromosomes possessed of the factor or gene for blackness in each primordial ovum; likewise there are two chromosomes bearing the factor for color in the primordial germ cell of the white animal. Following synapsis of the maturation process, these chromosomes separate and pass into two different germ cells in each of the animals. In crossing the two animals, the only possible zygotes that could arise would possess the two chromosomes with opposing potential genes; and since one gene is found experimentally to be dominant to the other, the offspring in this case are all black. In the primordial germ cells of these black individuals the synaptic relations again obtain, and as a result two kinds of germ cells arise, each pure for one of the two opposing characters. In a cross between these black pigs it is evident that four possible zygotes may result. Of these one would possess two chromosomes bearing the gene for blackness and is said to be homozygous for that factor and

develops a pure black animal. Likewise one zygote is homozygous for the white factor and is pure white, while two of the zygotes, on the other hand, possess both a white and black factor and are thus said to be heterozygous for the color factor; and since the gene for blackness dominates that for whiteness all of these heterozygous individuals are black. Thus there are three black individuals to one white individual in the second filial generation. On this same basis it would be possible to analyze the activity of the chromosomes in the dihybrid, trihybrid and polyhybrid crosses and to show that the Mendelian ratio which maintains in each case is a function of the chromosome relations.

Since there are a very large number of characters that are heritable and since the number of chromosomes is relatively small, it is evident that many factors for as many unit characters are associated upon the same chromosome, and usually appear together in inheritance. Darwin long ago recognized the fact that male albino cats with blue eyes were always deaf. This association is known as *linkage*. Genes for unit characters are linked together on individual chromosomes and usually remain so associated during the entire maturation of the germ cells. Linkage, however, does not always maintain. At the synaptic conjugation, chromosomes very frequently entwine around each other so that when they separate it often happens that entire blocks of chromomeres pass from one of the conjugant chromosomes to the other; so that new chromosomes are thus formed, possessed of homologous chromomeres. This interchange of genes is called "crossing over"; and its frequency is not haphazard, but seems to appear in a rather definite percentage of cases. When a black fly with vestigial wings is crossed to a gray fly with long wings, all the offspring are gray and have long wings. If now a gray long female is crossed to a black vestigial male, four kinds of offspring are produced, viz: black with vestigial wings, gray with long wings, black with long wings, and gray with vestigial wings. The black individuals with long wings and the gray individuals with vestigial wings represent about 17 per cent of the offspring and are the results of a crossing over of the genes from one chromosome to another following synapsis.

The differential cause of sex has always been a favorite subject for speculation. Varied explanations have been advanced, among which are external temperature, food or age conditions. Since there are only two possible results, almost any hypothesis could be proven correct a certain number of times; but it is highly improbable that sex is determined by any extrinsic factor. Experimental evidence seems to show that sex is a Mendelian character, and that a female is produced from a zygote that is usually homozygous for the sex factor; while the male is heterozygous for the factor. In each chromosome group a certain one is now regarded as a sex-determining chromosome. If, for example, two of these are present in the zygote, the individual resulting therefrom will be a female; while if but a single sex determiner is present, a male is the result. According to studies upon the spermatozoa of man, it appears that two sizes of two different kinds arise. Of these, one contains twenty-four chromosomes, twenty-three plus a sex determiner, and the other contains but twenty-three

chromosomes; one-half of all the spermatozoa lack a sex determiner, as it is called. Studies on the human ova show that all mature ova possess twenty-four chromosomes, twenty-three plus a sex determiner, as is true for one-half of the spermatozoa. If a spermatozoa, lacking the sex determiner, should fertilize any ovum, the result would be a zygote, heterozygous for the sex factor and a male would develop. But on the other hand, should fertilization be induced by a spermatozoan possessed of a sex determiner, a zygote results which would be homozygous for the sex factor and a female develops. Thus sex is apparently a matter of chromosome activity and it is not likely that it will ever be controlled.

The sex-determining chromosome not alone bears the factor for sex, but carries with it certain other genes for various unit characters. Thus it appears that certain physiological or pathological conditions accompany a certain sex; that is, they are joined in inheritance to the sex determining chromosome. These characters which so follow the sex chromosome are said to be sex-linked. Haemophilia and color-blindness are characteristics that are associated with sex. In these cases it is usually the males that are affected; for the defect is always transmitted from the mother who appears to be normal, since the factor for the defect is a simple recessive to the normal. To produce a color-blind female, it would require two determiners, one from the father and the other from the mother; whereas but a single determiner would produce the defect in the male.

There is no longer a doubt but that the main characters of every living thing are primarily determined by the architecture of the germ plasm. These differential causes are passed from generation to generation and our family traits are largely determined by the hereditary constitution of our ancestors. The basis for the existing differences for variations is determined by the combinations and separations, the linkages and the crossovers, of the genes or the chromomeres of the germ cells. May it be understood that this view does not postulate an absolutism in development. The germ cell is not a closed unit, and the adult characters, as we come to know them, are not represented in minature on the chromosome. Personality is not determined by heredity alone; nor are our habits, reactions and characters predetermined in the germ plasm. Germinal characteristics are not actual, but potential; and their actuality must be a function of numerous complicated reactions of the reproductive and the environmental factors. Potentiality is much greater than actuality. During normal development a given portion of an embryo produces only a certain portion of the body; but should such a portion be isolated from other parts, it will give rise to an entire individual. Such is its exceeding extent of potentiality. Furthermore, environmental factors may be introduced which so completely modify an individual's development that we must conclude that we are not only a product of ancestral specifications but of the co-ordinating extrinsic factors of the environment.

Hereditary possibilities are fundamental, however, and a superior environment can never produce more than the potentiality of the germ complex; but, conversely, it must follow that even a superior germ complex must forever remain dormant unless stimulated into activity by an environ-

ment. Seldom does a potential individual become actual. The innate germ plasm yearns for expression; but the requisite extrinsic factors fail to call it forth. Thousands of personalities with all the native endowments of genius, leadership and action, fail, for want of proper environmental stimuli, to come into being. Self-discovery is education's greatest challenge. To help us to know ourselves, to provide for us those extrinsic factors that shall call to fruition our latent possibilities; here is a task which for educators transcends all others.

Since we cannot control our hereditary legacy and since the environment of our formative years is largely beyond our choosing, it follows that life as we know it is much the resultant of antecedent causes. In a sense, an individual is not free, but is partly bound by a determinism that controls his entire personality, his body and mind; and yet as growth ensues and intelligence becomes manifest, less and less is an individual bound to the past, and more and more does he sense his freedom of choice and will. Some one has said that "Freedom is the more or less limited capacity of an individual to inhibit instinctive acts by intellectual and rational stimuli and to regulate behavior in the light of past experience."

Fundamental in the program that society must pursue to secure its own improvement is, first, the recognition of the power of the germ cell complex, and, co-ordinate with this, society must induce such an invigorating environment for it members, at home and at school, as to bring forth each latent power; that an individual may not only know but that he shall compel himself to know, and thus advance well toward that mastery and self-control which makes for better citizenship.

Arthur Sweeney, M. D., St. Paul: I am going to discuss this paper very briefly; first, for the reason that it is almost impossible in a short time to analyze all the points of the mechanism of Mendelian discoveries and to apply them to human beings. If I can get as far as the sex proposition--but by that time I shall arrive at the stage where I used to be in analytical geometry, in trigonometry and calculus, where they have those long things, X's, Y's, Z's and Q's. I never could get as far as the writer has gone with experiments with flies and color blindness. I find my mind is not capable of taking it all in. The plain facts of the Mendelian theory have been demonstrated so often and are so sound that we must reckon on them in our daily life.

I was in the hospital for the insane at Yankton the other day and my attention was called to an Indian 15/16 pure, who had a peculiar history. He had paresis, by the way, which is rather a strange thing to find in an Indian, but his history shows that some years ago a Scotch trader married an Indian, and they had Indian children, with characteristic Indian traits. In the third generation there was one Scotchman, with light, sandy hair, blue eyes, and all the characteristics of a Scotchman. All the rest of the children were real Indians.

That is the only instance I can recall where there was a distinct, pronounced Mendelian process in the human. We see certain characteristics transmitted, such as red hair or short, stout bodies, or strong, big frames;

but we are not able to classify them because it is difficult to trace those things on account of the indefinite number of children. We do not know as yet the proportions, nor the dominant qualities, nor which qualities are recessive. But we have got to reckon with this fact, though, that in dealing with physical characteristics of the individual, we can understand and assume that in men and women there are the same Mendelian processes at work that work among cows, guinea pigs, and so on, and we can, without violence to our intellect, assume that the Mendelian characteristics obtain in men, as well as in animals.

How about the other qualities? A man is not merely an animal; he is a thinking animal; he has a mind which has two phases. He has an intellect in which are the powers of perception and fixed attention, associative memory, that teaches him the result of past experiences. Then comes judgment, or choice, which leads to the source of his action and will power, which is inherent in the decision which he makes. If he decides to do one thing or the other his will is automatic. If he decides to do nothing, there is no choice.

We find in practice and by psychological examination that these five qualities in men follow very distinctly the line of heredity, but not in the proportion of three to one. We find that imbeciles that marry imbeciles almost universally produce low-grade, degenerate stock. We find that sound stock produces good stock, but not in the proportion of one to three. We do not know, of course, the dominant factors, nor are we able to collect proper statistics. There is another quality of mind that we must consider most important because it is the side of a man's mind that is used most. The emotional side of the individual is the side that is operative in most of us. We are in all our actions emotional reflexes. It is impossible for us to trace in the variegated kaleidoscopic field of emotion any such mechanism as the Doctor has spoken of here. Our thought reactions are so complex, are so mixed up, that it is impossible to form any definite conclusion except this, that, as a rule, where the intellectual side is most dominant, control of the emotions is apt to be most perfect.

I am inclined to doubt the cogency of the recommendation, which the Doctor makes with regard to environment. I am impressed by the all-overpowering factors of what a man receives at the time of his birth. You can not put a quart of water into a pint cup, and you can not put a certain amount of brains into a skull that is of less physical capacity. I think that when we come to consider men in their relations of life and their adaptability to the conditions of life, we find that they react absolutely according to the quality of the germ plasm which they received at birth. If their ancestry was good, their reaction is good; and if their ancestry is unfortunate, not all the good surroundings in the world will do anything except gloss over the real man; and when a crisis comes into his life, he is going to go back to the savage or degenerate that he originally was.

I feel that environment is important. Environment is what society requires. The man who is adaptable to his environment is a citizen. The man who is not adaptable to his environment is an outlaw. So, when we come to consider crime, pauperism, dependence, and so on, we find that the

criminal, the pauper, the dependent, and so on, belong to their particular type because of the qualities which they received from their ancestors. Taking the degenerate, feebleminded moron and putting him into fine surroundings, dressing him up and giving him all the education and all the refinements of life that normal children have, does not prevent him from reverting in the majority of cases.

I have very little confidence in the environmental theory for the reason that the inheritance of acquired characteristics is not yet proven and is a very difficult proposition. In our social life we enter into certain contacts, we form certain ideas, we join certain religious societies, we make certain emotional manifestations, all adaptable to society as we see it; but it will take more than one generation and more than two generations and more than ten generations to have chromosomes formed that will have those particular qualities of emotional adaptability in a person that is defective. In other words, acquired characteristics are not often transmitted. You can dress the moron in silks, give him a high school education and make him conform to his obligations and duty, but I do not believe that moron meeting moron and producing children is going to reproduce those very desirable qualities in their descendants.

The Chairman: We should like to hear from you, Dr. Kilbourne.

Arthur F. Kilbourne, M. D., Rochester State Hospital: I do not believe I am capable of discussing the paper. I certainly enjoyed it very much, and I think we all have a better idea of the subject. Dr. Sweeney ably expressed it by saying that when a man is born he has received all the brain power he will ever have and that may be developed to its limit by education.

I also agree with the Doctor when he says that environment has very little to do in shaping a man's intellectual future. I am inclined to think, however, that, inasmuch as chance plays such a large part in our progress through life, environment might influence our future welfare in so far as we are capable of progressing.

I feel that while we are on this question of heredity, after we have proved all these theories, and we have proved that from nothing nothing comes, the question arises, What are we going to do to create a better race of men? It seems to me that we fall down terribly in the limitation of the propagation of the feebleminded and the unfit. I have patients, chronic cases, who go out and somehow or other secure a license and find some clergyman to marry them. It seems to me that little is done to stop the multiplication of the mentally deficient. I care not what it is, so that it is effective; whether it is sterilization or continual confinement in an institution. We have a law, I believe, that prohibits the marriage of the mentally unfit. Whether or not it is in effect it is never enforced. You never hear of any penalty accruing to people who do not observe that law. I think the time has come and is long past when something should be done to prevent the propagation of the mentally unfit.

The Chairman: Dr. Freeman.

Geo. H. Freeman, M. D., St. Peter State Hospital: Mr. Coleman honors me by feeling I am able to discuss a paper of this character. There are a great many who have traits of goodness in them who are unable to show them because of their environment. I think we are not paying enough attention to the environment in holding down the good that is in some of us.

The Chairman: Dr. Baskett.

George T. Basket, M. D., Willmar State Asylum: I have enjoyed this paper very much, but as this is my first appearance here I think I would better say very little. However, I have been interested in the problem of heredity, especially from the viewpoint of the insane and our immigration. I should like to see this studied out a little more carefully, especially since Minnesota is a state that is made up so largely of people that come from the other side of the water.

The Chairman: Mr. Hanna.

C. C. Hanna, School for Feebleminded: I am not qualified to discuss this paper, but I do wish to express my appreciation to Dr. Higgins for his splendid paper. I am in accord also with what Dr. Sweeney has said. It is certain that feeblemindedness, epilepsy and insanity are inherited qualities, and that no progress will ever be made where this theory is left out of consideration.

Chas. E. Vasaly, State Reformatory: I feel very little qualified to discuss this subject, and there is, as you know, a very large and extensive territory where it is said angels fear to tread. I might get into that territory by some questions I might ask.

I should like to ask Dr. Sweeney if some of his theories would not relieve the individual of responsibility for his actions. The brighter men in my charge like to blame their troubles on their ancestors. They see no reason why the court should blame them.

Dr. Sweeney: Of course we all like to have alibis and most of us can think of good ones, but when you come down to the individual, it concerns not so much the individual as society which he has offended. We do not hold it against a criminal because he is a college graduate. All we say is this: A man is supposed under the law to know his relations to society and to live up to a certain social standard. If he does not keep such relations, he is put away. I do not think any court would take into consideration as a defense for murder or a defense for robbery that the prisoner has the mentality of a child of nine years. It is not a question of punishment; it is a question of the protection of society.

This question has been brought to me when I have examined persons accused of crime and when the lawyers have tried to get me to say that because a man has a feeble mentality and can not understand the law he should not be held guilty. I have always refused to take that ground. I have always said: Everybody is expected to conform to the law. If he is unable to adapt himself to social life, put him away.

C. J. Swendsen, Member State Board of Control: Being a layman, I am not going to discuss the question of heredity. I have had occasion to observe for many years the unfortunates in our penal and correctional institutions, and I have come to the conclusion that environment has a great deal more to do with the unfortunate state of the criminal than heritage. We are taking mental tests in the institutions, and we find that from 24 to 26 per cent are more or less feebleminded. How about the 75 per cent? We know from experience that about 80 per cent of the unfortunates come from bad homes, where the environment has been such that I have always asked myself this question: If I had had that sort of environment and that sort of a home, would I not have been in the same place? I have come to that conclusion in almost every case.

I think we should not forget the heritage. We should take such steps as are necessary to see that persons who are mentally deficient do not propagate their own kind, as we know they always do.

But there is another side to the question. We should see that the environment is in accord with the American scale of living.

I want to ask Dr. Sweeney a question. I heard you say that if you dressed morons in silk, put them in good environment, and then put them through high school and college, they will not then be able to take their place in society. Can you put a moron through college?

Dr. Sweeney: I regret to say that a great many fellows that get through college have no more sense than the average moron.

Dr. Kilbourne: I should like to call Mr. Swendsen's attention to the fact that the poor environment of which he speaks might be due to mental incapacity.

Mr. Swendsen: That may be true to some extent. You can lay it to the social conditions in life. If you will analyze it and follow it down you will find that greed for the almighty dollar is responsible to a great extent. Take the people who live in tenement houses. I do not believe that they are mentally unfit just because they are poor.

Mr. Vasaly: I should like to ask Dr. Kilbourne what he means by environment. I have some gentlemen in my charge who come from good homes. Did the grandfather have too many evil chromosomes?

Dr. Kilbourne: You can not separate environment from heredity. People who have good homes would have better ones if they had greater mentality. You are trying to separate intellectuality from certain characteristics that lead to crime. There are certain criminal tendencies in intellectual people. You get intellectual people with obsessions. If an individual has criminal tendencies it is no sign his intellect is not pretty fair, but his moral nature is not developed. There is a quirk in it.

J. T. Fulton, State Training School: Can you imagine anything that would make a man feel he is no good at all more than to settle on some of these extreme views with regard to heredity or environment?

Dr. Sweeney: The people who have a poor environment and a poor mentality do not know it. The average man of that type has the weak brain and the strong back. He is satisfied with his condition.

Sam F. Fullerton, St. Paul: We have a case now where we claim a man drove his wife insane by cruelty. There is no question about it. He claimed that her insanity was brought on by syphilis. We have followed that woman since she was a child, and a purer woman we claim does not live. We claim that she did not contract syphilis from association with men. Is it possible that her grandfather transmitted it to her? Five weeks after she was married they sent her to the hospital.

Dr. Higgins: As far as we can now determine, there is no such thing as inherited syphilis. There is no such thing as inherited disease; that is, when inheritance is construed to mean the actual germinal transmission. She probably could not have acquired from her parents any defect in the germ cells that would have appeared in her subsequent development. There may be an acquisition of disease very early in life, and sometimes disease appears to be inherited. What is actually inherited, however, is a constitution which is more or less susceptible to the disease. It would be very difficult to analyze the case you mention. She probably acquired the disease externally in some way; possibly through her husband, or by contact with infected articles of her environment; certainly not through any heritage.

Jos. E. Vance, School for the Blind: I should like to ask Dr. Higgins a question.

In dealing with blind children we recognize that there is such a thing as inherited eye condition. In Dr. Wood's report (he is the eye specialist) which he makes upon the entrance of every child to the institution, he very often states that the eye condition is due to inherited lues, or whatever it is. Is such a thing possible, or are we using wrong terms which are misleading to the medical profession?

Dr. Higgins: It is the very same thing as certain other defects, as color-blindness; it is an inherited defect which appears to be normal for that particular individual. I would say it could be carried from one generation to another just as it might be normal for one to have certain color of eyes or hair. There happened to be that particular defect in the germ plasm. Saying that that particular thing is inherited is perfectly logical because it so happens that that particular thing is characteristic for that particular germ plasm. Of course those are pathological defects.

I said diseases were not inherited. I mean those diseases which are definitely infectious. One does not inherit tuberculosis or numerous others that we could mention; but in that particular pathological defect that you speak of, I feel confident that there exists a causal defect in the germ plasm.

Mr. Vance: Do you ever recognize that such a thing as blindness may be inherited?

Dr. Higgins: Oh, yes; I would think so. I do not profess to be a specialist in heredity; but I would think a pathological condition of the retina or the iris or anything of that kind might be inherited. That is, there would be something in the mechanism that would bring about a certain condition at a certain age. Baldness is inherited; obesity is inherited; because there is resident in the germinal complex some determinate character that brings about that condition.

Mr. Vance: Do you explain congenital syphilis in the same way?

Dr. Higgins: Congenital syphilis would be acquired in the early stages of development from an infected parent. We may, however, be incorrect.

Galen A. Merrill, State Public School: Mr. Chairman, I want to express my approval of Dr. Higgins' address this morning and my appreciation of his recognition of the influence of environment upon heredity.

My ideas with regard to heredity are largely the results of observation of the up-bringing of children who have what the doctors call a bad family history. Naturally the relative influence of heredity and environment is a question which concerns those of us charged with the responsibility of caring for such children and providing a new environment for them.

The question is, Which is the chief factor in determining the fate of a human life? If the immediate ancestry of a child includes one or more persons who were consumptive, insane or criminal, or otherwise physically, mentally or morally diseased, is that child foredoomed to be similarly afflicted? We certainly can not provide him with a new and better heredity. It is of the utmost importance, for the sake of the child, that we give him the benefit of a new and better environment and training, which we can provide for him. Undeniably a child may inherit a tendency to disease, physical, mental and moral. Such evils develop in children in families living under the same conditions and subject to the same habits of life, but I bank on environment, and believe that environment and training properly adjusted may become a controlling factor in arresting hereditary tendencies or diverting them into useful channels.

I do not share the belief expressed this morning by one of the speakers, at least, in the fatality of heredity. If we are anxious about the future of a child because of what we know of his heredity, I do not believe we need to feel that the fate of his ancestors must necessarily be his. Habits, ailments, handicaps, which produce erratic and unstable conduct, ought to be discovered and remedied if possible.

There probably would be little need for the institution which I represent if every child could be well born and well brought up. Unfortunately there are many who are ill born and not well brought up. Whether a child be well born or not, it is essential that he be well brought up. Indeed, an unfortunate heritage increases the need of good environment if the child is to become efficient and useful.

Professor Conklin, who is professor of biology in Princeton, in his book on "Heredity and Environment," says that the power of environment is so great that it may outweigh heredity, and that a relatively poor heredity

with excellent environmental conditions often produces better results than a good heredity with poor environmental conditions. Of course no sort of environment can do more than bring out hereditary possibilities, but as Dr. Higgins said this morning, those possibilities remain latent and undeveloped unless they are stimulated into activity by the environment.

Then Professor Conklin cites the parable of the talents as expressing a profound biological truth. Men differ in hereditary endowments. One receives ten talents; another receives but one; but the used talent increases manyfold; the unused remains unchanged and undeveloped; and although we may not be able to increase our inheritance, we may greatly improve that which we have.