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Heredity and Feeblemindedness

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The problems presented by almost everything of consequence to man seem to be just two: the problem of maintenance and the problem of replacement. Human life itself is no exception to this generalization and feeblemindedness as one aspect of human life presents the same problems of maintenance and replacement. In this case the problem of maintenance is to care adequately for the feebleminded who are already with us, while the problem of replacement is to replace these feebleminded with normal individuals in the next generation. While our first and immediate concern is to make the feebleminded of this generation as effective citizens as possible, the problem of the next generation must not be overlooked. Our present knowledge leaves much to be desired, but it is adequate, I believe, to enable us to approach the problem. From such knowledge as we have one fact is quite clear, namely, that heredity is vastly concerned and I believe further that of the two factors, environment and heredity, heredity is the more important in the great majority of cases.

Less than one hundred years ago we first learned that all living things are composed of units called cells. Of microscopic size, the structure of a typical cell can best be shown by a slide. While cells may vary greatly in external form, their general plan of internal organization shows certain common features. Practically all cells have a nucleus, a tiny fluid filled sac containing a very large number of minute granules, collectively known as chromatin granules in turn are composed of genes which are the determiners of heredity.

The simplest animals reproduce by the breaking of the parent body into two parts, each of which becomes a full fledged daughter in a short time. This is typical asexual reproduction. In most animals, however, reproduction is of another type, namely, sexual. Sexual reproduction involves the union of two different types of cells, one an egg cell which is relatively large and non-motile, and the other a sperm cell which is very small and motile. When the sperm and the egg cells unite, a single fusion cell is formed and conception has occurred. This single cell proceeds to divide and continues to do so until many cells have been formed, out of which, by a variety of processes, the parts of the future body are fashioned. Growth and development thus take place through cell division. As the cell divides, the nucleus also divides, and in the course of the nuclear division each one of the thousands of chromatin granules is divided so that each daughter cell has in its nucleus the same kinds of chromatin granules as its sister cell and as their common parent cell. This is readily illustrated by imagining the nucleus to be a sac containing thousands of beads each of a different color, corresponding to the chromatin granules. When the nucleus divides, each bead is also divided between the daughter

nuclei, so that every color of bead represented in the parent is also present in each daughter.

The human sperm cell was discovered about two hundred years ago. Fueled by poor microscopes and good imaginations the early imaginators thought they saw in the sperm cell a miniature human body, which as development proceeded unfolded like the bud of a flower. We have long since abandoned this idea of preformation, as it was called. But while there is no preformed human body in either germ cell, there are in the nucleus of the fertilized egg cell the chromatin granules containing the genes, which as development proceeds will interact with the environment to produce all the characteristics physical and mental which the future individual will possess. Although it is clear that many genes in *(illegible)* in the production of any one *(illegible)* there is in many cases opportunity of a single gene or a group of genes which give the character it's obvious caste.

Each reproductive cell at the time of fertilization possesses in its nucleus one complete set of genes for all physical and mental characteristics which the future individual will have. When the sperm and egg unite, there complete (*illegible*) of genes are ? brought together and each subsequent cell division, moreover, each gene divided between the daughter cell. The adult human body thus composed of quadrillions of cells all of which trace their lineage back to the fertilized egg and each of which contained in its nucleus two complete sets of genes one descended from the genes of the sperm cell, the other from the genes of the egg cell.

The condition just outlined (*illegible*) for the all the cells of the body with the exception, namely, the reproductive or germ cells. When the individual forms germ cells, the two sets of genes are separated so that each egg and sperm cell has just one set of genes. Not until the sperm and egg cell unite in fertilization are there again two sets of genes present in a single cell. The interesting feature in the reduction from two sets of genes to one set in (*illegible*) manner in which one two sets are separated. Corresponding paternal and maternal genes are always separated from each other. This is known in the law as segregation. In the distribution of these separated genes, however, no set scheme is followed, rather the laws of chance are realized. The resulting cells have each and a complete set of genes. Only very rarely is this set a complete set of maternal or paternal genes; usually it is a set composed of some paternal and some maternal genes. If one computes mathematically the number of different ways a single set of genes may be separated out of two sets, it will be found that in man there are between 16 and 17 million different ways. In other words every human being is capable of producing 16-17 million of genetically different germ cells, and since each parent has the same capacity, any given couple could produce more than a quadrillion different combinations (the product of 17 millions by 17 millions). Therefore, the chance of exactly duplicating a child in a family is about one in a quadrillion. Thus it is not surprising that barring identical twins, the children of a single family are not much alike.

Sometimes the corresponding genes contributed by the two parents differ in their effects in which case the effect of one gene may cover up more or less the effect of the

other. This is the law of dominance. This law together with the law of segregation, described above, were first formulated by Mendel working with pens in 1880 in an obscure monastery in Czeche-Slovakia.

Let us take a very simple cross to see how this mechanism works. If a pure black guinea pig and a pure white guinea pig, which lacks genes for black, be crossed, the offspring of the first generation will be all black. (Various slides shown to explain the cross.) If these offspring are crossed with each other, and enough crosses made to give the chance of distribution, it will be found that there are three blacks to one white. The usual inheritance of eye color in man follows the same course. If a pure brown-eyed parent is crossed with a blue-eyed parent, the first generation will all have brown eyes. If these in turn are crossed with each other, we will have in the second generation, three brown eyed to one blue eyed child. (Several slides shown.) Several characters of the sort may be studied simultaneously, for example, hair color and hair length.

If heredity were always as simple as it is in these illustrations, human inheritance should be easily deciphered. Various complications, however, upset such an expectation. 1, We have almost no genealogical data. One of the most conspicuous human characteristics is eye color. But if I were to ask you here to give the color of your grandparents' eyes, few of you could do so. 2, We cannot experiment with human crosses as we do with animal crosses. We must wait for such crosses to occur by chance. 3, In man characteristics instead of being determined by the set of genes, frequently require several sets. Multiple factors rather than single factors are thus involved, and this greatly complicates the situation. A simple example of this is afforded by the negro white cross. We know perfectly well that if a negro white cross is made, the resulting offspring are not all black as in the guinea pig but are intermediate or mulatto. Here several sets of genes must be present to insure full black pigmentation. If some only are present, the color is diluted.

In 1905 the first case of Mendelian inheritance in man ws reported by Farabee. The case in question was brachydactyly in which the fingers have but 2 joints instead of 3 and the thumb 1 joint instead of 2. Fortunately this condition is dominant to the normal.

In the thirty subsequent years the number of characters clearly inherited in man has increased enormously. Some of these characters behave as simple dominants, others, simple recessives, many are results of multiple factors. These characters include eye color, hair color, skin color, general body size, stature, numerous physical defects, susceptibility to diseases, and various types of mental deficiency. Quite clearly inherited tho' not as single characters, but rather as groups of such characters are general mental ability and special talents, such as musical ability, artistic ability, etc. These later are so complex, however, that analysis is extremely difficult.

Feeble-mindedness has in many cases a non-heredity basis. The best figures available seem to indicate that three fourths of all feeblemindedness is not all necessarily inherited in the same way. In one type there appears to be some similarity to the simple

inheritance seen in eye color, while in other types it is more complex, multiple factors certainly being involved.

Hunt has suggested that the data on intelligence levels might be interpreted as follows:

1. Idiots, lacking all genes required for normal mental development.
2. Imbecils, with only one of these genes.
3. Morons, with two genes.
4. Low Average, with three to five genes.
5. High Average, with seven or eight genes.
6. Superior, with nine genes.
7. Genius, with all ten genes.

One case that I always like to mention is the case of a certain Ohio family in which both parents were white and both feebleminded. There were twelve children. Ten of the children were feebleminded, two were normal. The two normal children were black, however, indicating illegitimate paternity. Here the color came in to label the outside genes which also brought normal mentality.

A year or so ago I had the pleasure of spending a day with Dr. Murdoch. He told me his social work, Miss Perkins, had gathered some very interesting data on families which had come repeatedly in several generations to Faribault and made the data available to me.

(Slides)

Dr. Kuhlmann told me some years ago that he had examined about 600 children from about 100 families in which both parents were feebleminded. Practically all of these children were feebleminded. The number of normal children was so small that they might well be accounted for by illegitimate paternity. It is thus clear that feebleminded parents beget feebleminded children, and three fourths of our feebleminded are so because they have inherited a definite lack from their parents. Nothing can be done to make these individuals normal any more than anything can be done to grow additional joints on fingers of brachydactylous individuals.

The genes which determine the characteristics thus act in a rather rigid way to map out future capacities of the organism. The fertilized ovum is a bundle of potentialities which determines to a large extent the capacities of the future individual. For the development of these capacities the environment may be adequate, much more than adequate or wholly inadequate.

An eminent American geneticist has summed up the matter admirable. "Heredity is the exposed film, environment is the developer, heredity is the raw material, environment is the craftsman, heredity is the score, environment is the performer. Better

still, heredity is the credit at Nature's bank, deposited for the individual at conception. One has ten talents, a second, five talents, and third, one talent. What they do with their endowments depends upon circumstances."