

the Church, upholding it by their prayers and proving themselves the very salt of the earth. But their company needs to be increased, that the Holy Spirit of prayer, the Intercessor, may have freer course in furthering amongst men God's purpose of establishing His Kingdom.

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## Heredity.

IT is a matter of common observation that children are both like and sometimes surprisingly unlike their parents. Their likeness in feature, habit, illnesses, temperament and so forth, we loosely call heredity. Their unlikenesses occasion comment, "Wherever does he get it?" We assume that particular trait has got into his character or physique in some other way.

In point of fact, however, unlikenesses as well as likenesses are inherited, if by "inherited" we understand "received from parents by way of the germ cells". There is much that is still profoundly mysterious. All origins go out in mystery. Nevertheless certain biological discoveries have recently been made that throw light on the subject, and open up possibilities of further knowledge of the greatest interest and importance.

The experiments of the Austrian Abbé, Mendel, with peas are pretty well known; and the law that he formulated, called after him "The Mendelian Law". He found that if peas with certain characteristics were crossed, the peas subsequently obtained reproduced these characteristics according to a certain regular proportion. If, for example, tall peas were crossed with dwarfs, the first generation were all tall, but the second generation were tall and dwarf in the proportion of three to one. The former characteristic, therefore, he called "dominant", the latter "recessive". It was found on further experiments that the same rule applied apparently to other plants besides peas, and to the animal world as well. It was presumed it would apply to human beings: But the possibility of experimental cross-breeding not being open, the matter could not be verified. The Mendelian law of heredity came, therefore, to be accepted; but it was not explained.

During the last thirty-five years, however, a great deal of experimental microscopic work has been done by hundreds of biologists, and the explanation now seems to be established

beyond reasonable doubt, and to open up a further field of investigation of the greatest interest. It appears that the most important part of the substances of two parents (both of the plant and animal worlds) which fuse together to form the nucleus of an offspring, consists of a whole series of tiny units to which the name "genes" has been given. These genes, it is believed, are the factors which determine heredity.

When the male sperm, of microscopic minuteness, penetrates the larger female cell and causes fertilisation, the genes in these two cells may combine in an infinite variety of ways to form the new cell, which by process of growth and repeated division gradually becomes the body of the new offspring. And the particular combination of genes in that first cell is perpetuated in every cell that develops from it, the genes themselves being the formative factors in the development of the body, governing such diverse things as height, colour of hair and eyes, development of organs and features, resistance to disease, temperament and so forth.

If a cell is examined under the microscope the nucleus which contains these genes can be clearly seen. It has a different appearance according to whether the cell is ready to divide or not. But when it is about to divide or is in process of division, minute dark wormy things are just visible. To these is given the name of "chromosomes". And these chromosomes carry the genes. In a loose way we may liken them to strings of beads, each gene being a bead, and each according to its position in the string having a vital function to fulfil in building up the body. These results have been established in the main by innumerable experiments with the fruit-fly, which for various reasons is peculiarly suitable, and it has even been established in some cases at what particular point along a chromosome a particular gene lies that fulfils a particular function in body-building.

Now the number of chromosomes in a cell varies according to the plant or animal concerned, but it is constant for all the cells of all animals or plants of a particular species. Thus a sweet-pea cell has fourteen, the fruit fly eight, a human being forty-eight. Always, however, there is an even number. They go in pairs. And the genes located in each member of a pair fulfil the same functions; so that if a particular gene happens to be defective, and its opposite number is sound, the development of the body in the particular part governed by that gene is not impaired. If both are defective, then the corresponding defect in the growth of the body appears. It is as if all plants and animals were provided with a complete set of spare parts; only if any spare part required were also

defective would the organism suffer. Now when a reproductive cell is formed, whether in male or female, its peculiar character is that it only contains one set of chromosomes. A male cell entering a female cell thus provides the initial cell of an offspring with its two complete sets of chromosomes, carrying two complete equipments of genes, one from the father and one from the mother. And it is very interesting to learn what happens. Take, for example, Abbé Mendel's peas. One or more of the genes governs height. If a certain gene is "defective" it will produce a dwarf pea. But there will only be a dwarf pea if both the genes concerned are thus defective. If one is sound, it is enough to enable the pea to grow tall. So the sound gene that controls the growth is called "dominant", and the other which lies low, so to speak, is called "recessive". Where both or one is dominant, then there will be height; only where both are recessive will the dwarf appear.

We can perhaps see best in diagrammatic form what happens. Suppose we cross a pure tall where both genes are dominant, with a dwarf where both are recessive.  $D =$  dominant,  $r =$  recessive.  $D.D. \times r.r.$  It is obvious if you take one from the father and one from the mother to form the new combination for an offspring, the only possible combination is one of each,  $D.r.$  And the dominant will have it. All the offspring of the first generation will be as Mendel found, "dominants". But if these are paired off with each other,  $D.r. \times D.r.$ , there are four ways of doing it:  $D.D.$ ,  $r.D.$ ,  $D.r.$ ,  $r.r.$  The first three containing each a dominant will produce tall peas; only in the fourth case with two recessives will there be a dwarf. The reason for the proportion, three to one, which Mendel discovered, is now apparent. And a good many other things begin to become apparent too, as we realize that owing to our physical kinship with all God's living world, the same things happen in the cells of human bodies. Let us look at one or two in particular.

Not all dominant characteristics are inherently superior to recessives. Brown colour in the eye, for example, is a dominant, and blue recessive. But plenty of people are perfectly satisfied with blue eyes. Fortunately for us, however, genes which are required to provide us with factors that are important or vital to our development are always dominant, otherwise the human race would soon peter out. Defective genes may be responsible for the failure of some vital organ to develop or function as it should; for example, for feeble-mindedness or feeble resistance to certain diseases; and being recessive they may be latent in apparently normal persons. And we may be carriers of hereditary defects without showing any signs

ourselves. Suppose in our diagram above D. were normal mindedness and r. feeble-mindedness, then all the children of the first generation would be all right. But if any of the offspring married into a family where feeble-mindedness were latent, the chances are one in four that any child would be feeble-minded; and three in four that the defect would be handed on to the next generation after. We can also see the dangers of in-breeding. If there is any latent defect in the family, and two children of the same family married, the chances are one in four that it would come out. Defects that are naturally eliminated by marrying with other stocks tend to develop by much in-breeding. On the other hand, we can see how that in the case of animals, where the weak or defective can be destroyed, in-breeding can produce also types of exceptional strength and purity.

Another problem becomes a little clearer too as a result of these discoveries; and that is the problem with which we began, as to how it is that a child will suddenly develop characteristics so unlike either parent or grandparent. It is possible for a recessive characteristic to lie dormant for generations, and then for it suddenly to appear. Not all families have portraits of distant ancestors; but it has happened more than once that in a child people have seen a remote ancestor come to life again, as they glance at an old family portrait on the wall.

And now to revert once more to the germ cells, and the genes, the carriers of our heredity. There is a very interesting set of hereditary characteristics known as sex-linked characteristics, because they go with the sex of the offspring; the general principles being that sons inherit from the mother, and daughters are carriers from their fathers to their sons. These particular characteristics, therefore, are not transmitted according to the Mendelian law, but by a law of their own. And the reason for it is this: In the male one of the chromosomes of a certain pair is smaller than its mate and is almost non-functioning. Consequently when the germ cells form containing only one set of chromosomes each, some germ cells will have the complete set, and some germ cells will have a set that is complete except for one small non-functioning chromosome. So that when the germ cells of two parents coalesce to form the beginning of a new offspring, either two cells containing complete sets may be united, in which case the result is a female; or two cells containing one complete set and one set containing this non-functioning chromosome may be united, in which case the result is a male. If "C" represents a normal chromosome and "c" the small non-functioning one occurring only in the male and characteristic of the male, we could represent it diagram-

matically thus: Female cell C.C. Male cell C<sup>1</sup>.c. Taking one from each and combining for new offspring, it is only possible to get the combination C.C<sup>1</sup>. which is female, or C.c. which is male.

Now all the characteristics governed by genes occurring in this particular chromosome will obviously be related to the sex of the offspring. Suppose there is such a defect in the C<sup>1</sup>. of the father, and not in the mother; then, obviously, no son can inherit it, but in every daughter it must be latent. Supposing such a daughter C.C<sup>1</sup>. marries a healthy male C.c., then the daughters will all be of the type C.C. or C.C<sup>1</sup>.; that is none will show the defect, but half of them will carry it, and be liable to transmit it to sons. But the sons will be of the type C.c. or C<sup>1</sup>.c.; and, if the latter, will exhibit the defect as "c" doesn't function. That is there is a fifty per cent. chance of sons of such mothers developing the defect.

To sum up: in a male the C. chromosome must have come from the mother, and the C. chromosome of a father must descend to a daughter. So that if there is any defect in that chromosome it must be inherited in that way. Sons will inherit from the mother, fathers will transmit through their daughters.

The most interesting characteristics that are linked in this way are colour-blindness and haemophilia, or bleeding disease. And the implications are that a man need not fear to marry, if he is clear of it himself, whatever the history of such defects in his ancestry. If he is clear himself he cannot pass it on. On the other hand if he has the defect, he must inevitably transmit it through any daughters he may have to subsequent generations, though in any case he can't pass it on to sons.

With regard to a woman, if her father has the defect, or if it is anywhere in the mother's ancestry by female descent from any male ancestor who has had it, the defect may be latent in her; and she may be liable to pass it on to her sons, or through her daughters to their sons.

Where there is a danger of passing on so serious a complaint as haemophilia, persons so liable ought not to have children. And it is another case where nature seems hardest on the woman. For while if a man is clear himself he can safely marry whatever his ancestral record, a woman perfectly healthy herself may have to refrain if it is in her ancestry.

Now it is not always as easy as this to decide what is due to heredity and what is the effect of environment and upbringing; to decide as between nature and nurture. For characteristics don't fall into convenient and mutually distinct categories. Indeed there are some which can be the product of either heredity or environment. And there are some due to heredity which can

be eliminated by environment, by supplying in some other way for a hereditary defect. An outstanding example of this latter type is the Crétin, the pitiful, slobbering, undeveloped, large-headed idiot. It has been found that his trouble is due to a defect in the genes that govern the growth of the thyroid gland; his mal-development comes from an insufficiency of thyroid; and he can be changed to a normal creature if his trouble be taken in time and he is fed on thyroid gland extracts.

It is well-known to-day that only very few diseases are definitely proved to be hereditary. The great majority commonly regarded as hereditary, such as tuberculosis, are not hereditary in themselves; but only a weakness of resistance is inherited, which makes the individual more liable to infection by the germ. Which means that if appropriate steps are taken to increase the resistance in other ways, that particular hereditary defect may not prove serious.

But if a good environment can help to counteract a defective heredity, a bad environment can equally thwart a good heredity, and prevent latent capacities of good from developing. So that if one is asked which is the more important, "Nature or nurture" the only really scientific answer would seem to be "Both." But if it is asked "Which needs most attention from us to-day?" I should be inclined to say "nature." It seems that there is no small danger of upsetting the balance of nature by a disproportionate attention to nurture and a comparative neglect of heredity. In days when conditions were hard and human life cheap, there is no doubt that the quality of our human stock was kept up by the ruthless process of "the survival of the fittest." But now that the humaner principles of a more Christian civilisation demand that we care for the sick and the weak, it is imperative that attention be also given to questions of heredity and the quality of the human stock. It is an aspect of things to which the Germans are wide awake to-day, and if we disagree with the paganism of some of their doctrines, and the ruthlessness of some of their methods, we cannot afford to be indifferent to the underlying problem they are trying to solve. Julian Huxley puts it like this, "The hereditary constitution sets the limits to the possibility of the stock, and environment determines which of those possibilities shall be realised. . . . But the best environment will not bring out good qualities in a child with really defective inheritance." The upshot would seem to be that we need to give attention both to Education and Eugenics; and that the more attention we give to improving conditions and giving all alike, whether of sound or defective heredity, the best chance in life, the more important it is to give equal attention in such ways as

are open to us, to restricting the propagation of serious hereditary weaknesses and defects. "Just as we ought to give every child which actually comes into the world the best possible environment and education, so we ought to try and ensure that the children who are to come into the world shall have the best possible constitution; and this can only be done by some control of the individual's right to bring children into the world." Something can be done, and ought to be done, by way of legislation for extreme cases. But for the most part we must rely on a sound and educated public opinion, in which the enlightened Christian conscience of the Churches should be taking a bigger part. Our knowledge of these matters is far from complete, but it is growing. And increase of knowledge means increase of responsibility. "For him that knoweth to do good and doeth it not, it is sin."

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*The Development of Religious Toleration in England, 1640-1660*,  
by W. K. Jordan, Ph.D. (George Allen & Unwin, Ltd.,  
21s. net.)

Dr. Jordan's massive and monumental work, of which this is volume III., is appearing at an opportune time, for the battle of 300 years ago may have to be fought again. The liberty of the subject is being challenged, not solely by the totalitarian States; and it is well that those who cherish freedom should study the fundamental principles of religious and political liberty which were hammered out upon the anvil of Civil War. In this volume an outstanding period in our nation's history is reached—the Long Parliament, the Commonwealth, the Restoration—and Dr. Jordan's examination is made with scrupulous care.

Considerable space is given to the Baptists, and Dr. Jordan suggests that "perhaps no other religious group in England during the period under survey made so important a contribution to the development of the theory of religious toleration as did the Baptists," and in another place he suggests there is reason for believing that, in the period prior to 1660, "the sect was larger than has usually been supposed."

It is safe to say that Dr. Jordan's work will become standard and indispensable. We look forward with keen anticipation to the concluding volume and the bibliography, which will be published concurrently.