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EUGENICS: ITS NATURE, IMPORTANCE AND AIMS

What Eugenics Is

Eugenics is the science of the improvement of the human race by better breeding or, as the late Sir Francis Galton expressed it:—"The science which deals with all influences that improve the inborn qualities of a race." The eugenical standpoint is that of the agriculturalist who, while recognizing the value of culture, believes that permanent advance is to be made only by securing the best "blood." Man is an organism—an animal; and the laws of improvement of corn and of race horses hold true for him also. Unless people accept this simple truth and let it influence marriage selection human progress will cease.

Eugenics has reference to offspring. The success of a marriage from the standpoint of eugenics is measured by the number of disease-resistant, cultivable offspring that come from it. Happiness or unhappiness of the parents, the principal theme of many novels and the proceedings of divorce courts, has little eugenic significance; for eugenics has to do with traits that are in the blood, the protoplasm. The superstition of prenatal influence and the real effects of venereal disease, dire as they are, lie outside the pale of eugenics in its strictest sense. But no lover of his race can view with complaisance the ravages of these diseases nor fail to raise his voice in warning against them. The parasite that induces syphilis is not only hard to kill but it frequently works extensive damage to heart, arteries and brain, and may be conveyed from the infected parent to the unborn child. Gonorrhea, like syphilis, is a parasitic disease that is commonly contracted during illicit sexual intercourse. Conveyed by an infected man to his wife it frequently causes her to become sterile. Venereal diseases are disgenic agents of the first magnitude and of growing importance. The danger of acquiring them should be known to all young men. Society might well demand that before a marriage license is issued the man should present a certificate, from a reputable physician, of freedom from them. Fortunately, nature protects most of her best blood from these diseases; for the acts that lead to them are repugnant to strictly normal persons; and the sober-minded young women who have had a fair opportunity to make a selection of a consort are not attracted by the kind of men who are most prone to sex-immorality.

The Need of Eugenics

The human babies born each year constitute the world's most valuable crop. Taking the population of the globe to be one and one-half billion, probably about 50 million children are born each year. In the continental United States with over 90 million souls probably 2½ million children are annually born. When we think of the influence of a single man in this country, of a Harriman, of an Edison, of a William James, the potentiality of these 2½ million annually can be dimly conceived as beyond computation. But for better or worse this potentiality is far from being realized. Nearly half a million of these infants die before they attain the age of one year, and half of all are dead before they reach their 23rd year—before they have had much chance to affect the world one way or another. However, were only one and a quarter million of the children born each year in the United States destined to play an important part for the nation and humanity we could look with equanimity on the result. But alas!

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only a small part of this army will be fully effective in rendering productive our three million square miles of territory, in otherwise utilizing the unparalleled natural resources of the country, and in forming a united, altruistic, God-serving, law-abiding, effective and productive nation, leading the remaining 93 per cent of the globe's population to higher ideals. On the contrary, of the 1200 thousand who reach full maturity each year 40 thousand will be ineffective through temporary sickness, 4 to 5 thousand will be segregated in the care of institutions, unknown thousands will be kept in poverty through mental deficiency, other thousands will be the cause of social disorder and still other thousands will be required to tend and control the weak and unruly. We may estimate at not far from 100 thousand, or 8 per cent, the number of the nonproductive or only slightly productive, and probably this proportion would hold for the 600 thousand males considered by themselves. The great mass of the yearly increment, say 550 thousand males, constitute a body of solid, intelligent workers of one sort and another, engaged in occupations that require, in the different cases, various degrees of intelligence but are none the less valuable in the progress of humanity, Of course, in these gainful occupations the men are assisted by a large number of their sisters, but four-fifths of the women are still engaged in the no less useful work of home-making. The ineffectiveness of 6 to 8 per cent of the males and the probable slow tendency of this proportion to increase is deserving of serious attention.

It is a reproach to our intelligence that we as a people, proud in other respects of our control of nature, should have to support about half a million insane, feeble-minded, epileptic, blind and deaf, 80,000 prisoners and 100,000 paupers at a cost of over 100 million dollars per year. A new plague that rendered four per cent of our population, chiefly at the most productive age, not merely incompetent but a burden costing 100 million dollars yearly to support, would instantly attract universal attention. But we have become so used to crime, disease and degeneracy that we take them as necessary evils. That they were so in the world's ignorance is granted; that they must remain so is denied.

The General Procedure in Applied Eugenics

The general program of the eugenist is clear—it is to improve the race by inducing young people to make a more reasonable selection of marriage mates; to fall in love intelligently. It also includes the control by the state of the propagation of the mentally incompetent. It does not imply destruction of the unfit either before or after birth. It certainly has only disgust for the free love propaganda that some ill-balanced persons have sought to attach to the name. Rather it trusts to that good sense with which the majority of people are possessed and believes that in the life of such there comes a time when they realize that they are drifting toward marriage and stop to consider if the contemplated union will result in healthful, mentally well-endowed offspring. At present there are few facts so generally known that they will help such persons in the inquiry. It is the province of the new science of eugenic to study the laws of inheritance of human traits and, a these laws are ascertained, to make them known. There is no doubt that when such laws are clearly formulated many certainly unfit matings will be avoided and other fit matings that have been shunned through false scruples will be happily contracted.

THE METHOD OF EUGENICS

Unit Characters and Their Combination

When we look among our acquaintances we are struck by their diversity in physical, mental, and moral traits. Some of them have black hair, others brown, yellow, flaxen, or red. The eyes may be either blue, green, or brown; the hair straight or curly; noses long, short, narrow, broad, straight, aquiline, or pug. They may be liable to colds or resistant; with weak digestion or strong. The hearing may be quick or dull, sight keen or poor, mathematical ability great or small. The disposition may be cheerful or mecancholic; they may be selfish or altruistic, conscientious or liable to shirk. It is just the fact of diversity of characteristics of people that gives the basis for the belief in the practicability of improving the qualities of the "human harvest." For these characteristics are inheritable, they are independent of each other, and they may be combined in any desirable mosaic.

The method of inheritance of these characteristics not always so simple as might be anticipated. Extensive studies of heredity have, of late years, led to a more precise knowledge of the facts. The element of inheritance is not the individual as a whole nor even, in many cases, the traits as they are commonly recognized but, on the contrary, certain unit characters. What are, indeed, units inheritance and what are complexes it is not always easy to determine and it can be determined only by the results of breeding. To get at the facts it is necessary to study the progeny of human marriages. Now marriage can be and is looked at from many points of view. In novels, as the climax of human courtship; in law, largely as a union of two lines of property-descent; in society, as fixing a certain status; but in eugenics, which con-

siders its biological aspect, marriage is an experiment in breeding; and the children, in their varied combinations of characters, give the result of the experiment. That marriage should still be only an *experiment* in breeding, while the breeding of many animals and plants has been reduced to a science, is ground for reproach. Surely the human product is superior to that of poultry; and as we may now predict with precision the characters of the offspring of a particular pair of pedigreed poultry so may it sometime be with man. As we now know how to make almost any desired combination of the characters of guinea-pigs, chickens, wheats, and cottons so may we hope to do with man.

At present, matings, even among cultured people, seem to be made at haphazard. Nevertheless there is some evidence of a crude selection in peoples of all stations. Even savages have a strong sense of personal beauty and a selection of marriage mates is influenced by this fact, as Darwin has shown. It is, indeed, for the purpose of adding to their personal attractiveness that savage women or men tattoo the skin, bind up various parts of the body including the feet, and insert ornaments into lips, nose and ears. Among civilized peoples personal beauty still plays a part in selective mating. If, as is sometimes alleged, large hips in the female are an attraction, then such a preference has the eugenic result that it tends to make easy the birth of large, well-developed babies, since there is probably a correlation between the spread of the iliac bones of the pelvis and the size of the space between the pelvic bones through which the child must pass. Even a selection on the ground of social position and wealth has a rough eugenic value since success means the presence of certain effective traits in the stock. The general idea of marrying health, wealth, and wisdom is a rough eugenic ideal. A curious antipathy is that of red haired persons of opposite sex for each other. Among thousands of matings that I have considered I have found only two cases where both husband and wife are red headed, and I am assured by red haired persons that the antipathy exists. If, as is sometimes alleged, red hair is frequently associated with a condition of nervous irritability this is an eugenic antipathy.

In so far as young men and women are left free to select their own marriage mates the widest possible acquaintance with different sorts of people, to increase the amplitude of selection, is evidently desirable. This is the great argument for coeducation of the sexes both at school and college that they may increase the range of their experience with people and gain more discrimination in selection. The custom that prevails in America and England of free selection of mates makes the more necessary the proper instruction of young people in the principles of eugenical matings.

The theory of independent unit characters has an important bearing upon our classifications of human being and shows how essentially vague and even false in conception these classifications are. A large part of the time and expense of maintaining the courts is due to this antiquated classification with its tacit assumption that each class stands as a type of men. Note the extended discussions in courts as to whether A belongs to the white race or to the black race, or whether B is feeble-minded or not. Usually they avoid, as if by intention, the fundamental question of definition, and if experts be called in to give a definition the situation is rendered only worse. Thus one expert will define a feeble-minded person as one incapable of protecting his life against the ordinary hazards of civilization, but this is very vague and the test is constantly changing. For a person may be quick-witted enough to void being run over by a horse and carriage but not quick enough to escape an automobile. A second expert will define a feeble-minded person as one who cannot meet all (save two) of the Binet test for three years below his own; if he fail in one only he is no longer feeble-minded. But this definition seems to me socially insufficient just because there are moral imbeciles who can answer all but the moral question for their proper age. Every attempt to classify persons into a limited number of mental categories ends unsatisfactorily.

The facts seem to be rather that no person possesses all of the thousands of unit traits that are possible and that are known in the species. Some of these traits we are better off without but the lack of others is a serious handicap. If we place in the feeble-minded class every person who lacks any known mental trait we extend it to include practically all persons. If we place there only those who lack some trait desirable in social life, again our class is too inclusive. Perhaps the best definition would be: "deficient in some socially important trait" and then the class would include (as perhaps it should) also the sexually immoral, the criminalistic, those who cannot control their use of narcotics, those who habitually tell lies by preference, and those who run away from school or home. If from the term "feeble-minded" we exclude the sexually immoral, the criminalistic, and the narcotics such a restriction carried out into practice would greatly reduce the population of institutions or that class. Thus one sees that a full and free recognition of the theory of unit characters in its application to man opens up large social, legal and administrative questions and leads us in the interests of truth, to avoid classifying *persons* and to consider rather their *traits*.

The Mechanism of the Inheritance of Characteristics

That traits are inherited has been known since man became a sentient being. That children are dissimilar combinations of characteristics has long been recognized. That characteristics have a development in the child is equally obvious; but the mechanism by which they are transmitted in the germ plasm has become known only in recent years.

We know that the development of the child is started by the union of two small portions of the germ plasm—the egg from the mother's side of the house and the sperm from the father's. We know that the fertilized egg does not contain the organs of the adult and yet it is definitely destined to produce them as though they were there in miniature. The different unit characters, though absent, must be represented in some way; not necessarily each organ by a particle but, in general, the resulting characteristics are determined by chemical substances in the fertilized egg. It is because of certain chemical and physical differences in two fertilized eggs that one develops into an ox and the other into a man. The differences may be called *determiners*.

Determiners are located, then, in the germ cells, and recent studies indicate a considerable probability that they are to be more precisely located in the nucleus and even in the chromatic material of the nucleus. To make this clear a series of diagrams will be necessary.

In the division of a cell into two similar daughter cells the most striking fact is the exact division of the chromatin. We know enough to say that the nucleus is the center of the cell's activity and for reasons that we shall see immediately it is probable that the chromatin is the most active portion of the nucleus.

The fertilization of the egg brings together determiners from two germ plasms and we know that, on the whole, the two germ cells play an equal rôle in carrying determiners. Now the germ cells are of very different size in the female (egg) and the male (sperm). Even the nuclei are different; but the amount of chromatic substance is the same. Hence it seems probable that the chromatic substance is the carrier of the equal determiners.

But if determiners from the male are added to those from the female in fertilization it would seem necessary that the number of these determiners should double in every succeeding generation. There must be some special mechanism to prevent this result. An appropriate mechanism is, indeed, ready and had been seen and studied long before its significance was understood; this is the elimination from both the immature egg and the immature sperm of half of the chromatic material. Thus if the immature sex-cell contains four chromatic bodies (chromosomes) each mature sex-cell will contain only two chromosomes. Moreover, each of the chromosomes in the immature sex-cell is double; one half having originated long before in its maternal germ plasm and the other half in its paternal germ plasm. The mechanism for maturation is such that either the paternal or maternal component of any chromosome is eliminated in the process, but not both. Beyond the condition that one half of each kind of chromosome must go to each daughter cell it seems to be a matter of chance whether the portion that goes to a particular cell be of paternal or of maternal origin. It is even conceivable that one germ cell should have all of its chromosomes of maternal origin while the other cell has all of a paternal origin.

The important point is that the number of chromosomes in the ripe germ cell has become reduced to half and so it is ready to receive an equal half number from the germ cell with which it unites in fertilization.

The Laws of Heredity

We are now in a position to understand the modern laws of heredity. First of all it will be recognized that nothing is inherited except the determiners in the germ cells; the characters themselves, on the contrary, are not directly inherited. A clear grasp of this fact gives the answer to many questions. Thus the possibility of the transmission of somatic mutilations is seen to depend upon the capacity of such mutilations to modify the determiners in the germ plasm, and such capacity has never been proved. On the other hand, the germ cells receive nutritive and other particles from the blood and they may receive also poisons from it. Hence arises the possibility of depauperization of the germ plasm and of "race poisons;" but these are exceptional and little known phenomena.

To understand the way heredity acts, let us take the case where both germ cells that unite to produce the fertilized egg carry the determiner for a unit character, A. Then in the child that develops out of that fertilized egg there is a *double* stimulus to the development of the unit character A. We say the character is of *duplex* origin. If, on the other hand, only one germ cell, say the egg, has the determiner of a character while the other, the sperm, lacks it, then in the fertilized egg the determiner is *simplex* and the resulting character is of simplex origin. Such a character is often less perfectly developed than the corresponding character of duplex origin. Finally, if neither germ cell carries the determiner of the character A, it will be absent in the embryo and

the developed child. A person who shows a character in his body (soma) may or may not have the determiner for that character in all of the ripe germ cells he carries, but a person who lacks a given unit character ordinarily lacks the corresponding determiner in all of his germ cells; for, were the determiner present anywhere in his organization (including his germ cells) the corresponding character would ordinarily show in his soma.

In connection with the so-called Mendelian analysis of heredity a nomenclature has grown up which is somewhat different from that here employed. Thus the absent character is often called *recessive*, the present character *dominant* and the condition in the offspring resulting from a crossing of the two is called *heterozygous*, which is the equivalent of simplex. It is to be kept in mind that in this work "absence" does not always imply absolute but only relative absence. Thus the pigmentation of light brown hair is "absent" to "black," and "tow" is absent to light brown; but pigment is present in all these grades of hair. To avoid the confusion between relative and absolute absence the terms recessive and dominant are often used to advantage, wherever a series of grades of a character is under consideration.

These general principles may be rendered clearer by means of a Table of the different sorts of matings of germ cells. And, to focus attention, let us have in mind a concrete example; that of pigment of the iris of the human eye. In the following table P stands for the determiner of brown pigment and p for its absence. Six sorts of unions are possible.

In the case of an individual who has received the determiner for one of his unit characters from one side of the house only (say from mother), not only is the character simplex, but when the germ cells mature in that person they are of two types, namely, with the determiner and without the determiner; and these two types are equally numerous (Fig. 5). This is the phenomenon known as segregation of presence and absence in the germ cells. If both parents are simplex in a character, so that they produce an equal number of germ cells with and without the character then in a large number of offspring, 1 in 4 will have the character duplex; 2 in 4 simplex, and 1 in 4 will not have the character at all (nulliplex). This gives in the offspring of such a pair the famous 3 to 1 ratio, sometimes called the Mendelian ratio.

Now the foregoing rules, which we have illustrated by the case of eye-color, hold generally for any positive determiner or its unit character.

Inheritance of Multiple Characters

In the foregoing section we considered the simplest case, namely that in which a single character is taken at a time—*i.e.*, one parent has some character that the other lacks. We have now to consider the cases which are still commoner in nature where the parents differ in respect to two independent characters. Let, for example, the two characters be eye-pigment and hair curliness. Then each one of the six matings given in Table I for eye-color may occur combined with any one of the six matings for hair form; so that there would be a total of 6 times 6 or 36 possible combinations of matings. Similarly Table II would be replaced by one of 9 entries as follows.

The lessons that this enforces are: first, that characters are often and, indeed, usually, inherited independently and, secondly, that the outcome of a particular mating may be predicted with some precision; indeed, in many matings with certainty.

This study might be extended to cases of three or more independent characters but the tables in such cases become more complex and little would be gained by making them as the principle has been learned by the cases already given. In view of the

TABLE I Laws of Inheritance of Characters Based on Conditions of the Determiners in the Parental Germ Plasms

			Determiners	
Case	One Parent	Other Parent	Offspring	Characteristics of Offspring
1	PP	PP	PP, PP	All with pigmented iris (brown-eyed)
2	PP	Pp	PP, Pp	All pigmented, but half simplex
3	PP	pp	Pp, Pp	All pigmented and all simplex
4	Pp	Pp	PP, Pp, pP, pp	¼ duplex pigmented; ½ simplex; ¼ unpigmented (blue-eyed)
5	Pp	pp	Pp, pp	½ simplex; ½ unpigmented (blue-eyed)
6	pp	pp	pp, pp	All unpigmented (blue-eyed)

TABLE II Law of Condition of Eye-Characters in Children Based on the Characters of Their Parents

One Parent	Other Parent	Cases	Offspring
brown	brown	1, 2, 4	Either all of the children have brown eyes, or one fourth have blue eyes
brown	blue	3, 5	Either all children brown-eyed (though simplex) or half blue-eyed
blue	blue	6	All blue-eyed

great diversity of parents in respect to their visible characters the variability of children is readily accounted for.

Heredity of Sex and of "Sex-Limited" Characters

In most species, as in man, there are two sexes, and they are equally numerous. For a long time this equality has been a mystery; but of late years, through the studies of McClung, Wilson, Stevens and Morgan, the mystery has been cleared up. For there has been discovered in the germ plasm a mechanism adequate for bringing about the observed results. We now know that sex is probably determined strictly by the laws of chance, like the turn of a penny. The cytological theory of the facts is as follows. One sex, usually (and herein taken as) the female, has all cells, even those of the young ovary, with a pair of each kind of chromosome, of which one pair is usually smaller than the others and more centrally placed. The chromosomes of this pair are called the X chromosomes. In the male, on the other hand, the forerunners of the sperm cells have one less chromosome, making the number odd. This odd chromosome [exceptionally paired] is usually of small size and is also known as an X chromosome. In the cell-division that leads to the formation of the mature spermatozoon, this odd chromosome goes *in toto* to one of the two daughter cells. The X chromosomes are commonly regarded as the "sex-chromosomes." With them are associated various characters that are either secondary sex characters or "sex-limited" characters. Consequently in respect to each and every such character the primordial egg cells are duplex and all the ripe eggs have one sex determiner and its associated characters. The primordial male cells are simplex and consequently, after segregation has occurred, the spermatozoa are of two equally numerous kinds—with and without the sex-determiner. The fertilization of a number of eggs by a number of sperm will result in two equally common conditions—namely a fertilized egg, called *zygote,* that contains *two* sex determiners—such develops into a female; and a zygote that contains only one sex determiner—such develops into a male. The nature of the germ cells in the germ gland of the future child and of the associated secondary sex-characters thus depend on which of the two sorts of sperm cells go into the make-up of the zygote.

Whenever the male parent is characterized by the absence of some character of which the determiner is typically lodged in the sex chromosome a remarkable sort of inheritance is to be expected. This is called sex-limited inheritance. The striking feature of this sort of heredity is that the trait appears only in males of the family, is not transmitted by them, but is transmitted through normal females of the

TABLE III Law of Combined Inheritance of Eye-Color and Hair Form

One Parent	Other Parent	Offspring
Brown eye, curly hair	Brown eye, curly hair	Either all brown-eyed and curly-haired; or one-fourth blue-eyed and also one-fourth of all straight-haired (with or without blue eyes)
Brown eye, curly hair	Brown eye, straight hair	All (or all but one-fourth) brown-eyed, and either all or one-half straight-haired
Brown eye, straight hair	Brown eye, straight hair	All (or all but one-fourth) brown-eyed; all straight-haired
Brown eye, curly hair	Blue eye, curly hair	All (or one-half) brown-eyed; all (or three-fourths) curly-haired
Brown eye, curly hair	Blue eye, straight hair	All (or one-half) brown-eyed; all (or one-half) curly-haired
Brown eye, straight hair	Blue eye, straight hair	All (or one-half) brown-eyed; all straight-haired
Blue eye, curly hair	Blue eye, curly hair	All blue-eyed; all (or three-fourths) curly-haired
Blue eye, curly hair	Blue eye, straight hair	All blue-eyed; all (or one-half) curly-haired
Blue eye, straight hair	Blue eye, straight hair	All blue-eyed; all straight-haired

family. Striking examples of this sort of heredity are considered later in the cases of multiple sclerosis; atrophy of optic nerve; color blindness; myopia; ichthyosis; muscular atrophy; and haemophilia.

The explanation is the same in all cases. The abnormal condition is due to the absence of a determiner from the male X chromosome.

If the trait be a positive sex-limited one, originating either on the father's or the mother's side, its inheritance will be more irregular.

The Application of the Laws of Hereditary to Eugenics

If one is provided with a knowledge of the methods of inheritance of unit characters it might seem to be an easy matter to state how each human trait is inherited and to show how any undesirable condition might be eliminated from the offspring and any wished for character introduced. Unfortunately, such a consummation cannot for some time be achieved. The reason for the delay is twofold. First, we do not yet know all of the unit characters in man; second, we can hardly know in advance which of them are due to positive determiners and which to the absence of such.

Unit characters can rarely be recognized by inspection. For example the white coat color of a horse is apparently a simple character, but experimental breeding shows that it is really due to several independently inheritable factors. The popular classification of traits is often crude, lagging far behind scientific knowledge. Thus insanity is frequently referred to a single trait. It is clear, however, that insanity is a *result* merely and not a specific trait. Some cases of insanity indicate an innate weakness of the nervous system such as leads it to break down under the incidence of heavy stress; other cases of insanity are due to a destruction of a part of the brain by a wound as, for instance, of a bullet. In some cases, through infection a wide-spread deterioration of the brain occurs; in other cases a clot in a cerebral blood vessel may occlude it, cut off nutrition from a single locality of the brain and interfere with movements that have their centres at the affected point. Now these four results cannot be said to be due to the same unit defect; and they can hardly be compared in the study of heredity.

On the other hand, the original expectation that progress must wait on a complete analysis of unit characters proves not to be correct. There are a number of forms of insanity that are sharply separable symptomatically and structurally which have a common basis in that they are due to a nervous weakness; and "nervous weakness" may behave in heredity with relation to "nervous strength" like a lower grade, or the absence, of a highly developed character. Even without a complete analysis of a trait into its units we may still make practically important studies by using the principle that when both parents have low grades of a trait-complex the children will have low grades of that complex.

The matter of dependence of a character on a determiner or its absence is of great importance and is not easy to anticipate. For instance, long hair as in angora cats, sheep or guinea pigs is apparently not due to a factor added to short hair but rather to the absence of the determiner that stops growth in short-haired animals. One can only conclude whether a character is due to a determiner or to its absence by noting the effect of breeding likes in respect to the given trait. If all offspring are like the parents in respect to a trait, the trait (if simple) is probably a negative one. But if the offspring are very diverse, the trait (if simple) is probably due to a positive determiner and the germ cells of the parents are of two kinds; some with and some without the determiner.

The determination of unit characters is complicated by the fact that a character due to a simplex determiner often differs from one due to a duplex determiner. In the former case the character is slow in developing and frequently fails of reaching a stage of development found in the latter case. The offspring of red and black-eyed birds may have at first a light iris which gradually darkens. This fact is spoken of as the imperfection of dominance in the simplex condition.

Despite the difficulties in analysis of units of heredity and despite the complications in characters it is possible to see clearly the method of inheritance of a great number of human traits and to predict that many more will become analyzed in the near future.