# A DIAGRAM OF HEREDITY.

FRANCIS GALTON.

January 27, 1898

Galton, Francis. 1898. A diagram of heredity. *Nature*, 57:293.

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*Some standard textbook descriptions of early genetics give the impression that, besides Mendel, no one attempted any genetic analysis in the entire nineteenth century. This is far from the truth, with Francis Galton offering a fine refutation. Starting just a few years after Mendel (and also working with peas), Galton carried out a series of well-received studies that resulted in his "Ancestral Law of Heredity," summarized diagrammatically in this brief communication. Galton's "Law" was so firmly established in some circles, that many adherents did not accept Mendelism until 1918, when R. A. Fisher showed that Galton's Law was in fact a natural consequence of Mendelian inheritance for polygenic traits.*

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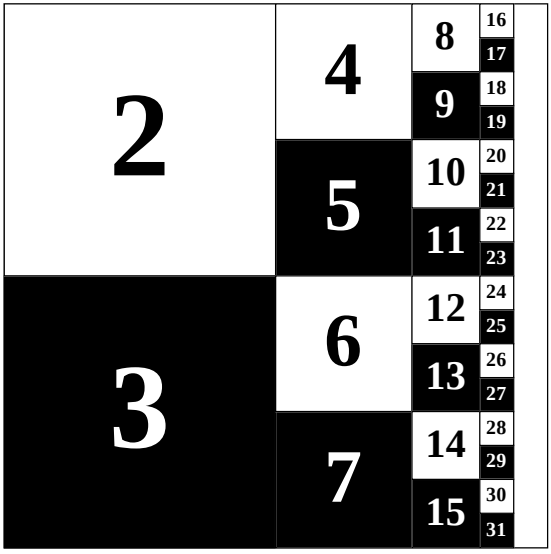
The law of heredity which was formulated by myself in a memoir entitled "The average Contribution of each several Ancestor to the total Heritage of the Offspring" (*Roy. Soc*. June 3 1897, and NATURE, July 8, 1897), and which, as I am exceedingly gratified to learn, is now strongly corroborated by an independent investigation, has recently been illustrated by a useful diagram This was devised by Mr. A. J. Meston, of Allen Farm, Pittsburg, Mass., U.S.A. and communicated by him to the *Horseman* (Chicago, December 28), the leading American newspaper on horsebreeding, together with a popular explanation of the law in question. Believing, as I do, and I am not now alone in the opinion, that the law is a real advance in hereditary science, I think that Mr. Meston's milestone diagram deserves a place in your columns, as conveying in a very intelligible form the chief features of the law.

These are that the total *heritage* of the offspring is derived as follows. The two parents between them, contribute *on the average* one half of each inherited faculty, each of them contributing one quarter of it. The four grandparents contribute between them one quarter, or each of them one sixteenth; and so on, the sum of the series ½ + ¼ + 1/8 + 1/16 + &c. being equal to 1, as it should be. It is a property of this infinite series that each term is equal to the sum of all those that follow: thus ½ = ¼ + 1/8 + 1/16 + &c.; ¼ = 1 /8 + 1/16 + &c., and so on. The prepotencies or subpotencies of particular ancestors, in any given pedigree, are eliminated by a law that deals only with *average* contributions, and the varying prepotencies of sex in respect to different qualities, are also presumably eliminated. Corrections for

these can of course be made in any particular pedigree, taking care that the corrected series still amounts to 1 exactly.




It should be borne in mind that the word “Heritage” has a more limited meaning than "Nature," or the sum of the inborn qualities. Heritage is confined to that which is inherited, while Nature also includes those individual variations that are due to other causes than heredity, and which act before birth. Now individual variation in a race that is stable, must have a destructive as often as a constructive effect Consequently its effects balance one another in average results, and disappear from a law which deals only with these.

The area of the square diagram represents the total heritage of any particular form or faculty that is bequeathed to any particular individual. It is divided into subsidiary squares, each bearing distinctive numbers, which severally refer to different ancestors. The size of these subsidiary squares shows the average proportion of the total heritage derived from the corresponding ancestors The distinctive numbers are the same as those which I employed many years ago in connection with the "Family Records" with which I was at that time engaged: they were found both then and subsequently to be very convenient. The Subject of the pedigree is numbered 1. Thenceforward whatever be the distinctive number of an ancestor, which we will call $n$, the number of its sire is $2n$, and that of its dam is $2n + 1$. All male numbers in the pedigree are therefore even, and all

female numbers are odd. To take an example — 2 is the sire of 1, and 3 is the dam of l; 6 is the sire of 3, and 7 is the dam of 3. Or, working backwards, 14 is a male who is mated to 15; their offspring is 7, a female, who is mated to 6; their offspring is 3, a female, who is mated to 2, and their offspring is 1, the Subject. The connection of all this with the binary system of notation is obvious, and need not be further alluded to. [In Mr. Meston's own diagram, the number I is assigned to the sire, and 2 to the dam, and so on. This detracts from the simplicity of the nomenclature, and therefore I do not adopt that part of his diagram.] The distinction between the male and the female squares is made still more conspicuous by colouring the latter; but, yielding to the exigencies of printing, I have replaced colour by printers' ink. So all male squares in my version of Mr. Meston's diagram have white grounds and black numerals, and all female squares have black grounds and white numerals.

The numbered squares could be continued indefinitely: in this small diagram they cease with the fourth generation, which contributes a 16th part of the total heritage, therefore the whole of the more distant ancestry, comprised in the blank column, contribute l/16th also.