

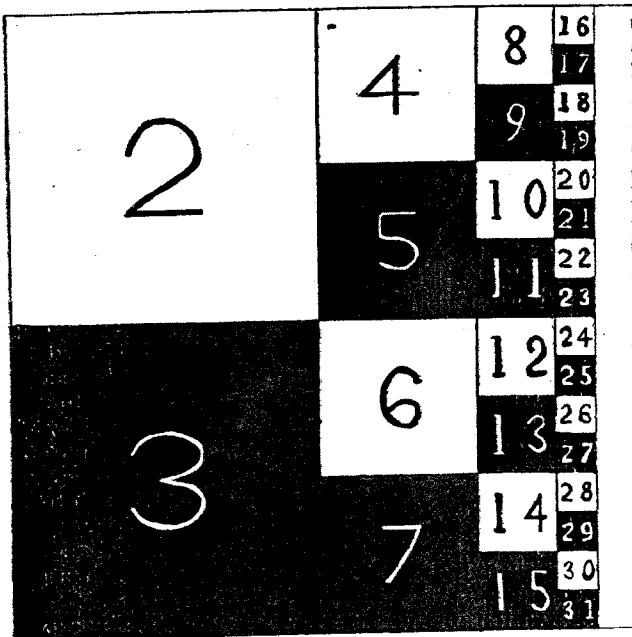
LETTERS TO THE EDITOR

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A Diagram of Heredity.

THE law of heredity which was formulated by myself in a memoir entitled "The average Contribution of the 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 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 $\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \dots$ 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 $\frac{1}{2} = \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \dots$; $\frac{1}{4} = \frac{1}{8} + \frac{1}{16} + \dots$, 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

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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 1; 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 1 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 $1/16$ th also.

FRANCIS GALTON.

"Some Unrecognised Laws of Nature."

PRESSURE of important business has prevented me from writing ere this to claim space in your columns to enter a protest against the misrepresentations, as well as the whole tone, of the review—which appeared in your columns of the 9th ult.—of the above work, in which I have had the privilege of assisting during the past six years. Heretics have long learned not to expect mercy, or even to look for justice, at the hands of the orthodox. But from a reviewer who, oblivious of the proverb *Qui s'excuse s'accuse*, warned his readers that he at least was "not one to regard lightly the danger of summarily rejecting a germ of new discovery because it happens to conflict with orthodox opinions," we have a right to expect something very different from the venomous outpourings and direful warnings and threats that might flow quite naturally from an irate theologian when reviewing a work which strikes a blow at the very foundations of his dogmas and doxies. And this is the very head and front of our offending, that, heedless of authority, we regard "the whole doctrine of 'energy,' with all its astounding and contradictory corollaries," as absurd; as the product of the infantile, and necessarily anthropomorphic, imagination of primitive man; and that we have attempted to show how phenomena may be accounted for without having recourse to such figments of the imagination. In this we may have succeeded or not; the immediate verdict will largely, if not entirely, depend on the mental attitude of the judge, and for the ultimate verdict we must be content to wait. But your reviewer may find some comfort in the assurance that the *facts* of science, slowly accumulated through long ages, would not be affected, nor need the human race necessarily be plunged "once more into pre-Galilean ignorance," even if all the assumptions, the metaphysical conceptions—of ethers, "dead" matter, "animating" energy, &c.—on which current explanations of these same facts are based, were summarily consigned to the limbo of similar long-forgotten "working hypotheses." And it is these hypotheses we assail, not the facts.

Of his criticisms of the fundamental principles, or rather principle, on which all our explanations are based, I need say nothing, for I can safely leave them to the judgment of all who take the trouble to read our work. I may mention, however, that his review is itself a strong *a posteriori* verification of the law of persistence in its application to psychological phenomena. But I must protest against the, conscious or un-