

**GENETIC DEFINITIONS
IN THE NEW STANDARD DICTIONARY**

G. H. SHULL

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INTRODUCTION

In this short paper, Shull takes exception to some recently published dictionary definitions of many technical genetics terms and he offers corrected definitions in their stead. The main value of this paper to modern readers is that it gives a good idea of what geneticists (or at least Shull) meant by their use of genetic terminology at the time.

Although many of Shull's proffered definitions would be at home in a modern biology text, some are no longer in current usage. For example, we now use "allele" in place of "allelomorph" and the terms "coupling" and "repulsion" used then to describe the theoretical behavior of alleles at loci that did not assort independently have now disappeared, since the problem they "explained" is now seen as a simple manifestation of genetic linkage.

The "presence and absence hypothesis" was another term defined to describe a phenomenon no longer believed to exist, at least not in the form considered here — that is, the idea that all mutant, deleterious alleles might not *be* anything at all, rather they might just be the *absence* of the actual allele that must be *present* for normal function to occur.

If Shull had expanded his definition of "alternative inheritance" by adding "contrast with continuous inheritance" at the end, it would have been much improved. At the time of his writing, *alternative inheritance* was often used to distinguish "Mendelian inheritance patterns" from the continuous patterns believed by some to be far better explained by Francis Galton's "ancestral law of inheritance." Indeed, in 1915 there was still a school of thought that argued that most heritable variation was continuous, but Mendelian theories only provided explanations for cases of "alternative inheritance," which were rare in nature and might only represent artifacts of inheritance in domesticated organisms.

For just such a criticism of alternative inheritance, see Weldon, W. F. R. 1902 Mendel's laws of alternative inheritance in peas. *Biometrika*, 1:228-254, soon to be republished by the Electronic Scholarly Publishing project.

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GENETIC DEFINITIONS IN THE NEW STANDARD DICTIONARY

G. H. SHULL

THE WIDELY ADVERTISED AIM of the Funk & Wagnalls Company to include in their "New Standard Dictionary of the English Language" all of the new additions to scientific terminology naturally invites the specialist in each branch of science to examine the definitions of the new words in his own field. Professor Miller¹ has called attention to the fact that the mathematical definitions are not reliable. The same criticism must be made regarding the definitions of many terms now familiar in the literature of genetics. For some of the errors in these definitions the editorial staff can not be blamed, because the errors were passing current among genetic writers themselves, at a time when further changes in the dictionary probably became impossible; other errors are less easily explained. While such a monumental work as the Standard Dictionary tends to fix the usage of language, the shortcomings of the genetic definitions may not be expected to seriously affect the terminology actually used by the specialists in this field; but for those who are engaged in other scientific fields, who have only a casual interest in genetics, and who must, therefore, depend upon the dictionary for the meaning of any genetic terms they may happen to meet, the erroneous definitions are unfortunate. While very few of the genetic definitions are free from defects, either of omission or of commission, only those which seem most obviously defective will be considered here. In the following list of words the definition of the New Standard Dictionary is stated first, and then follows, in italic type, a definition which I believe will meet with the approval of most geneticists.

Acquired. Transmitted by inheritance to subsequent generations; as, *acquired* characters.

¹ *Science*, N. S., 38: 772, November 28, 1913.

Acquired character. *A modification of bodily structure or habit which is impressed on the organism in the course of individual life.*

Both of these definitions occur in the New Standard Dictionary, the first under “acquired,” the second under “character.” Although “impressed on” may not be the best figure of speech to use in this connection, the second definition represents fairly well the correct usage of this phrase. It is difficult to understand why essentially the same definition should not have been given at both places.

Allelomorph. “In Mendelian inheritance a pair of contrasted characters which become segregated in the formation of reproductive cells.”

Allelomorph. *One of a pair of contrasted characters which are alternative to each other in Mendelian inheritance. Often used with doubtful propriety as a synonym for gene, factor or determiner.*

The defects in the dictionary definition in this case are two: (a) The definition is plural, while “allelomorph” is singular; the “allelomorph” is not a *pair* of characters, but a *single* character. (b) No segregation of allelomorphs takes place in the formation of asexual reproductive cells.

Allelomorphism. “The presence of allelomorphic pairs of characters.”

Allelomorphism. *A relation between two characters, such that the determiners of both do not enter the same gamete, but are separated into sister gametes.*

Alternative inheritance. “The transmission to alternating generations of descendants of the characteristics of either parent, as that of the father to the odd, and of the mother to the even generations”

Alternative inheritance. *A distribution of contrasting parental or ancestral characters among offspring or descendants, such that the individuals exhibit one or other of the characters in question, combinations or blends of these characters being absent or exceptional.*

Biotype. “In Mendelian inheritance a race or strain that breeds true or almost true; a term introduced by Johannsen.”

Biotype. *A group of individuals all of which have the same genotype.*

The word “biotype” was introduced into English by Dr. Johannsen² in 1906 with the definition “one single ‘sort’ of organisms.” It is a term of general applicability and not limited to Mendelian races, as stated in

² Report of the third International Conference of Genetics, p. 98.

the New Standard Dictionary. Although homozygous biotypes generally do breed true, this is not an essential feature and therefore should not be included in the definition. Ever-sporting varieties are now well known which do not breed true, but which, so far as present evidence goes, do constitute single homozygous biotypes. Heterozygous biotypes generally do not breed true.

Clon. "A plant-group the members of which have been grown from an original stock, but which do not come true from seed."

Clone. *A group of individuals produced from a single original individual by some process of asexual reproduction, such as division, budding, slipping, grafting, parthenogenesis (when unaccompanied by a reduction of the chromosomes), etc.*

There are several defects in the dictionary definition of this word, even if restricted to a plant-group in accord with the original meaning given to it by Webber, who introduced the word. The defects consist, first, in the ambiguity of the word "stock," because we may grow plants "from an original stock" of seeds, quite as well as from cuttings, while a clone is derived from a single individual; second, the statement that clones do not come true from seed is incorrect, for a clone formed by cuttings, etc., from a homozygous individual does "breed true.," *i. e.*, it produces seedling offspring of its own type. The word is now being generally applied to animals as well as to plants.

Coupling. ("Genetic coupling" is not defined in the dictionary.) *Such a relation between the genes of two unit-characters that they have a more or less marked tendency to be included in the same gamete when the individual is heterozygous for both of the genes in question.*

Cross-over. (Not given a genetic definition in the dictionary.) *A separation into different gametes, of determiners that are usually coupled, and the association of determiners in the same gamete, which are generally allelomorphic.*

Cryptomere. "A plant character which may exist in the germ-cells without making its presence visible."

Cryptomere. *A factor or gene whose presence can not be inferred from an inspection of the individual, but whose existence can be demonstrated by means of suitable crosses.*

The chief defect in the dictionary definition is the restriction of this term to plant characters. "Cryptomere" is a general genetic term which may be applied as well to animals as to plants.

Determiner. "The same as determinant 3."

Determiner. *An element or condition in a germ-cell which is essential to the development of a particular feature, quality or manner of reaction of the organism which arises from that germ-cell; a gene or factor.*

The word “determiner,” as used in recent years, is not the equivalent of “determinant 3,” which latter is correctly defined in the dictionary in terms of Weismann’s complicated hypothesis. “Determiner,” “factor” and “gene” are now quite generally used interchangeably without implication as to their fundamental nature, simply in the generic sense, as “that which determines.”

Dominance. “In the cross-bred offspring of parents with marked mutually antagonistic characteristics, the exhibition by such offspring or its descendants of one of these characteristics to the exclusion of the other.”

Dominance. *In Mendelian hybrids the capacity of a character which is derived from only one of the two generating gametes to develop to an extent nearly or quite equal to that exhibited by an individual which has derived the same character from both of the generating gametes. In the absence of dominance the given character of the hybrid usually presents a “blend” or intermediate condition between the two parents, but may present new features not found in either parent.*

There are several defects in the dictionary definition. In the first place, the parents used in a given cross may not themselves be homozygous, in which case some of their offspring will resemble one parent and some the other; in such a case, according to the dictionary, both of the contrasted characters would exhibit dominance. The phrase “or its descendants” would make it possible, *in any case*, to include both recessives and dominants, since among the *descendants* of such cross-bred individuals there will also be *recessive* individuals which “exhibit one of the characteristics to the exclusion of the other.”

Dominant. “(1) A marked parental character exhibited by a cross-bred organism and its descendants. (2) The parent, cross-bred organism, or descendant exhibiting such character. Parental characters latent in a crossbred organism, but actively evidenced by its descendants, are called *recessives*, as are the descendants which exhibit them.”

Dominant. *(1) A character which exhibits dominance, i. e., that one of two contrasted parental characters which appears in the individuals of the first hybrid generation to the exclusion of the alternative, “recessive,” character. (2) An individual possessing a dominant character, in contrast to those individuals which lack that character, which are called “recessives.”*

An “*extracted dominant*,” as defined in the dictionary, is not distinguishable from the pure homozygous dominant used in the cross from which the dominant in question was “*extracted*,” as no mention is made of the essential historical fact that it is of hybrid origin and that its parent or other known ancestor did not breed true to the same dominant character.

Factors. “Latent physiological units which upon crossing give rise to the new characters found in the hybrid.”

Factor. *An independently inheritable element of the genotype whose presence makes possible any specific reaction or the development of any particular unit-character of the organism which possesses that genotype; a gene or determiner.*

The limitation of the term “factor” to those cases in which new characters appear in hybrids, is not in accord with present usage. All the various characters of organisms are to an important degree dependent upon the existence of genotypic factors, regardless of the behavior of these organisms in crosses.

Gen. “A minute hypothetical particle supposed to be the bearer of hereditary qualities.”

Gene. *An element of the genotype; a genetic factor; a determiner.*

The treatment of this word in the dictionary is particularly mischievous. When I introduced the word “gene” to English-reading students, I said:³ “This word is proposed by Dr. Johannsen . . . to denote an internal something or condition upon whose presence an elementary morphological or physiological characteristic depends. The word ‘gene’ has the advantage that it does not assume by its form or derivation any hypothesis as to the ultimate character, origin or behavior of the determining factor.” In adopting the word “Gen” in the German, Johannsen said:⁴ “Das Wort *Gen* ist völlig frei von jeder Hypothese; es drückt nur die sichergestellte Tatsache aus, dass jedenfalls viele Eigenschaften des Organismus durch in den Gameten vorkommende besondere, trennbare und somit selbständige ‘Zustände,’ ‘Grundlagen,’ ‘Anlagen’ — kurz, was wir eben *Gene* nennen wollen-bedingt sind. . . . die Gene sehr vieler Eigenschaften glatt trennbar sind, während andere nicht oder nicht glatt sich trennen. Dies alles erinnert an das Verhalten chemischer Körper. Damit ist aber noch gar nicht gesagt, dass die Gene selbst chemische Gebilde oder Zustände seien — darüber wissen wir vorläufig noch gar nichts.” How different

³ *Am. Nat.*, 43, p. 414, 1909.

⁴ “Elemente der exakten Erblchkeitslehre,” 1. Aufl., 1909, pp. 124-125.

is all this from “a minute hypothetical particle”! It is obviously improper, therefore, to define a gene as a “minute particle.” Neither is it correct to say that it is “supposed to be the bearer of hereditary qualities. “It is only the something of unascertained nature, which must lie at the foundation of any elementary hereditary quality. The spelling “gene” is not even mentioned in the dictionary as a variant, yet this was the original spelling and is now in practically universal use among geneticists, while no one uses “gen.”

Genotype. “A race of organisms different from another in its hereditary qualities; contrasted with phenotype.”

Genotype. *The fundamental hereditary constitution or sum of all the genes of an organism.*

The unfortunate definition of “genotype” given in the dictionary was current in America at the time when the dictionary forms were probably closed, so that the editors are not in any way to blame for the totally erroneous definition. The definition given by the dictionary for “genotype” fits fairly well the word “biotype.”

Heredity. “The tendency manifested by an organism to develop in the likeness of a progenitor.”

Heredity. *The distribution of genotypic elements of ancestors among the descendants; the resemblance of an organism to its parents and other ancestors with respect to genotypic constitution.*

The results of modern experimental work on heredity show that the definition given by the dictionary is entirely too restricted. Heredity must be so defined that it may apply to characters that were never exhibited by any ancestor.

Heterozygosity. “In Mendelian inheritance, the state or condition due to an organism having developed from a heterozygote.”

Heterozygosity. *The condition of an organism due to the fact that it is a heterozygote; the state of being heterozygous; the extent to which an individual is heterozygous.*

Heterozygote. “A Mendelian hybrid resulting from the fusion of two gametes that bear different allelomorphs of the same character and which in consequence does not breed true; contrasted with homozygote.”

Heterozygote. *A zygotic individual in which any given genetic factor has been derived from only one of the two generating gametes. Both eggs and sperms produced by such an individual are typically of two kinds, half of them containing the gene in question, the rest lacking this gene; consequently the offspring of heterozygotes usually consist*

of a mixture of individuals, some of which possess the corresponding character while others lack it.

Homozygosis. “Development from a zygote originating from a union of two gametes of the same kind.”

Homozygosis. *The state of being homozygous; the extent to which an individual is homozygous.*

Homozygote. “A zygote formed by the conjugation of two gametes of the same stock; any animal or plant that receives and retains the dominant or recessive characters of both its parents, and is therefore said to be true to type, and breeds true to type.”

Homozygote. *An individual in which any given genetic factor is doubly present, due usually to the fact that the two gametes which gave rise to this individual were alike with respect to the determiner, in question. Such an individual, having been formed by the union of like gametes, in turn generally produces gametes of only one kind with respect to the given character, thus giving rise to offspring which are, in this regard, like the parents; in other words, homozygotes usually “breed true.” A “positive” homozygote with respect to any character contains a pair of determiners for that character, while a “negative” homozygote lacks this pair of determiners.*

“Two gametes of the same stock” is ambiguous because of the indefiniteness of the word “stock.” Many homozygotes receive some dominant *and* some recessive characteristics of the two parents and what can be intended by the statement that a plant or animal which receives certain characteristics also “*retains*” them? How could it do otherwise?

Hypostasis. (Not given a genetic definition in the dictionary.) *That relation of a gene in which its usual reaction fails to appear because of the masking or inhibitory effect of another gene; contrasted with “epistasis.”*

The corresponding adjective “hypostatic” is also not given a genetic definition in the dictionary.

Mendelize. “To cause to follow Mendel’s law of inheritance.”

Mendelize. *To follow Mendel’s law of inheritance.*

The word is rightly indicated in the dictionary, as an intransitive verb; it is manifestly incorrect to define it by the use of a transitive verb.

Mutant. “That which admits of or undergoes mutation or change; specifically, an individual or a species which shows significant changes in form or character in a single generation.”

Mutant. *An individual possessing a genotypic character differing from that of its parent or those of its parents, and not derived from them by a normal process of segregation.*

The expression “significant changes” is ambiguous, since every change is significant of something.

Mutate. “To ‘sport.’”

Mutate. *To undergo a change in genotypic character independently of normal segregation.*

The word “sport” which is used in the dictionary definition of “mutate” is defined thus: “To vary suddenly or spontaneously from the normal type; said of an animal or plant or of one of its parts.” It is well known that many such sudden and spontaneous variations from the normal type are not due to mutations. The word “mutation” is defined in the dictionary as “a permanent transmissible variation in organisms, as distinct from fluctuation.” This definition is good as far as it goes, but should expressly exclude transmissible variations which are due to normal segregation and recombination of determiners.

Phenotype. “A type or strain of organisms distinguishable from others by some character or characters, whether their observable differences from other organisms be due to their inherent hereditary differences or to the direct action of the environment upon them: contrasted with *genotype*.”

Phenotype. *The apparent type of an individual or group of individuals, i. e., the sum of the externally obvious characteristics which an individual possesses, or which a group of individuals possesses in common; contrasted with genotype.*

“Phenotype” and “genotype” are both abstractions; the qualities which distinguish the phenotype are always capable of direct observation, while those of the genotype can only be inferred from the results of genetic experiments.

Presence and absence hypothesis. “in the Mendelian doctrine of inheritance, the theory that an allelomorphic pair of characters in every zygote has two contrasted factors or determinants, one representing the positive character of the generated organism and the other denoting its absence.”

Presence and absence hypothesis. *The hypothesis that any simple Mendelian difference between two individuals, results solely from the presence of a factor in the genotype of the one individual, which is absent from that of the other. Presence and absence of unit-differences as a convenient method of describing the results of genetic experiments should be carefully distinguished from the*

presence and absence hypothesis. The method is purely objective and entirely free from hypothetical implications.

It will be noted that the dictionary definition of this phrase is directly opposite in significance to the one here set forth.

Pure line (Not included in the dictionary.) *A group of individuals derived solely by one or more self-fertilizations from a common homozygous ancestor. Sometimes erroneously applied to groups of individuals believed to be genotypically homogeneous (a homozygous biotype or a clone) without regard to their method of reproduction.*

Repulsion. (Not given a genetic definition in the dictionary.) *Such a relation between two genetic factors that both are not, as a rule, included in the same gamete, referring especially to cases in which the factors in question give rise to obviously different characteristics; also called "spurious allelomorphism."*

Sex-limited inheritance. (Not defined in the dictionary.) *The association of the determiner for any unit-character, with a sex-determiner, in such a manner that the two determiners are either generally included in the same gamete, or that they are generally included in different gametes. This method of inheritance is also called "sex-linked" inheritance by Professor T. H. Morgan and his students.*

Segregate. "To become separated from the rest; specif., of Mendelian hybrids, to separate, by a numerical law, into dominants, hybrids and recessives."

Segregate. *With reference to Mendelian unit-characters, to become separated through the independent distribution of the genetic factors before or at the time of the formation of the gametes.*

The dictionary definition goes too far; the formation of dominants, hybrids and recessives depends not alone upon the fact that the factors *segregate*, but that the segregated factors *recombine*. The word "segregation" receives a fairly satisfactory definition.

Unit-character. (Not included in the dictionary.) *In Mendelian inheritance a character or alternative difference of any kind, which is either present or absent, as a whole, in each individual, and which is capable of becoming associated in new combinations with other unit-characters.*

I have made no systematic study of the definitions of technical terms in other related fields, but have noted incidentally that there is no recognition in the New Standard Dictionary of the generally familiar usage of the words "meristic" and "substantive" as applied to types of variation.