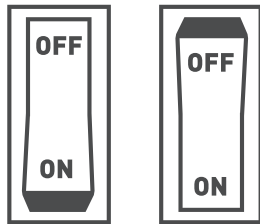


Measuring Phenotype: Penetrance vs. Expressivity

These two genetic terms are central to evaluating health. The first, penetrance, refers to the percentage of individuals with a specified genotype and exhibiting the expected phenotype. The second term, expressivity, considers the severity of the phenotype among affected individuals with a specified genotype. These concepts are employed regularly in evaluating health, and are especially important in the interpretation of genetic test results.

PENETRANCE

PENETRANCE MEASURES THE PRESENCE OR ABSENCE OF THE ASSOCIATED TRAIT.



Many traits, regardless of inheritance pattern, are incompletely penetrant. This means that for a given allele, the proportion of individuals who show the expected physical, behavioral, and/or metabolic trait can vary.



INCOMPLETE PENETRANCE

EXPRESSIVITY

EXPRESSIVITY MEASURES THE PHENOTYPIC SEVERITY.



Both the external and internal environments of a patient contribute to the phenotypic severity with which a pathogenic variant manifests. Measures of expressivity describe severity of the trait arising from a specified allele or genotype. Traits that follow any inheritance pattern can be measured in this way.



VARIABLE EXPRESSIVITY

FURTHER CONSIDERATIONS

Even for traits with 100% penetrance, expressivity often varies. For instance: 100% of the individuals who inherit a duplicate Chromosome 21 develop Down's Syndrome (complete penetrance). However, due to variable expression, the severity of disease among individuals living with an extra copy of Chromosome 21 varies widely.

The binary nature of penetrance makes it much easier to measure than expressivity. It is typically expressed as a percentage. Expressivity, on the other hand, is quantified in ways that are relevant to the phenotypic trait in question. This can mean: variance in lab values for a specific trait (i.e. hemoglobin g/dL), comparing individuals for a pre-defined spectrum of behaviors (i.e. the autism spectrum or certain cancers), or directly measuring physical features (i.e. limb length measured in cm). Unlike penetrance, expressivity is measured in qualitative or quantitative terms.