Transmission Probabilities: Two Traits

In this module we calculate the probability that a child will be affected by two rare genetic diseases. In completing these problems, we employ both the familiar **principles of genetic transmission** of autosomal and X-linked traits, along with a **fundamental rules of probability**:

The Multiplication Rule for the Probability of Independent Events

Assume the probability of each of two events occurring is p(E1) and p(E2). If the events are independent (the occurrence of one event does not affect the probability of the other event occurring), then the probability of *BOTH* events occurring equals:

$$p(E1 \text{ and } E2) = p(E1) * p(E2)$$

(the probability of one event happening *TIMES* the probability of the other event happening):

An example

The probability of flipping a coin and having it come up "heads" is 1/2.
The probability of rolling a die and obtaining a "4" is 1/6.

The probability of obtaining a "head" and a "4" in both flipping a coin and rolling a die is:

$$P(\text{"head" and "4}) = 1/2 * 1/6 = 1/12$$

This module assumes you are familiar with the basic principles of transmission for autosomal and X-linked traits. A few specific points relevant to this topic are included below.

An Assumption about Dominant Traits

Since all the genetic diseases in this module are quite rare, we assume that individuals affected by a dominant disease are heterozygous (rather than homozygous dominant). The exception is that males affected by an X-linked dominant trait are *hemizygous*, rather than heterozygous, since they only have one X chromosome.

Some Relevant Transmission Principles for Recessive Traits

- If a trait is **autosomal recessive**, the probability that an unaffected individual is a carrier equals the frequency of carriers in the population.

  * The probability a child will inherit an **autosomal recessive** disease allele from an unaffected parent equals (the probability the parent is a carrier) AND (the probability a child will inherit a disease allele from a parent).

- If a trait is **X-linked recessive**, the probability that an unaffected female is a carrier equals the frequency of female carriers in the population. (Males cannot be carriers of X-linked traits, since they only have one X chromosome.)

  The probability a child will inherit an **X-linked recessive** disease allele from an unaffected mother equals (the probability the mother is a carrier) AND (the probability a child will inherit a disease allele from a parent).