11-2 Probability and Punnett Squares

How do geneticists use the principles of probability?

Genetics and Probability

The likelihood that a particular event will occur is called **probability.**

The principles of probability can be used to predict the outcomes of genetic crosses.

In order to measure probabilities, mathematicians have devised the following formula for finding the probability of an event.

Probability Of An Event

$$P(A) = \frac{\text{The Number Of Ways Event A Can Occur}}{\text{The Total Number Of Possible Outcomes}}$$

Experiment:

A single 6-sided die is rolled.

What is the probability of each outcome (rolling a 1, 2, 3, 4, 5, or 6)?

What is the probability of rolling an even number?

What is the probability of rolling an odd number?

How do geneticists use Punnett squares?

Steps to Using a Punnett Square to Predict the Genotype and Phenotype of Offspring

1. Determine which characteristic is dominant and recessive.
2. Determine the genotypes of both parents.
3. Determine the possible gametes each parent can produce.
4. Create a Punnett Square showing a cross between the parent's gametes (fertilization).
5. Determine the genotypes (genotypic %, ratio, or fraction) of the offspring.
6. Determine the phenotypes (phenotypic %, ratio, or fraction) of the offspring.

Punnett Squares

The gene combinations that might result from a genetic cross can be determined using a **Punnett square.**

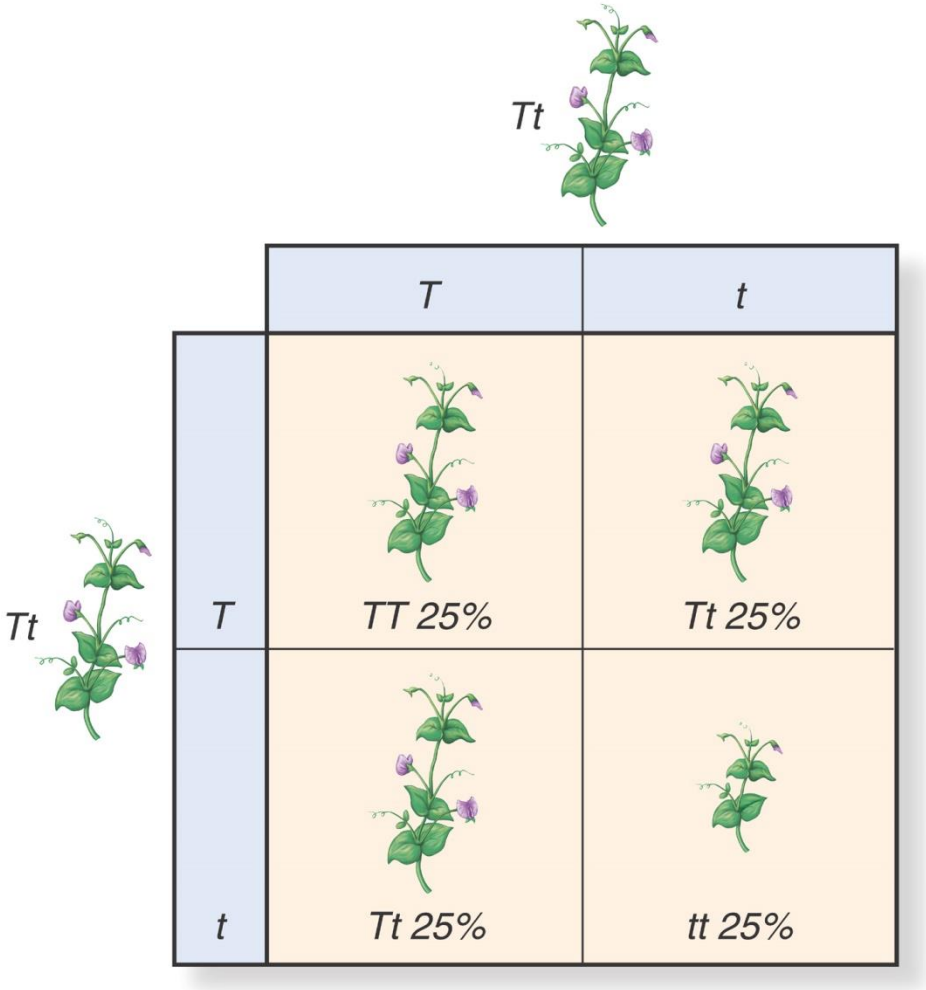
Punnett squares help predict and compare the genetic variations that will result from a cross.

A capital letter represents the dominant allele for tall.

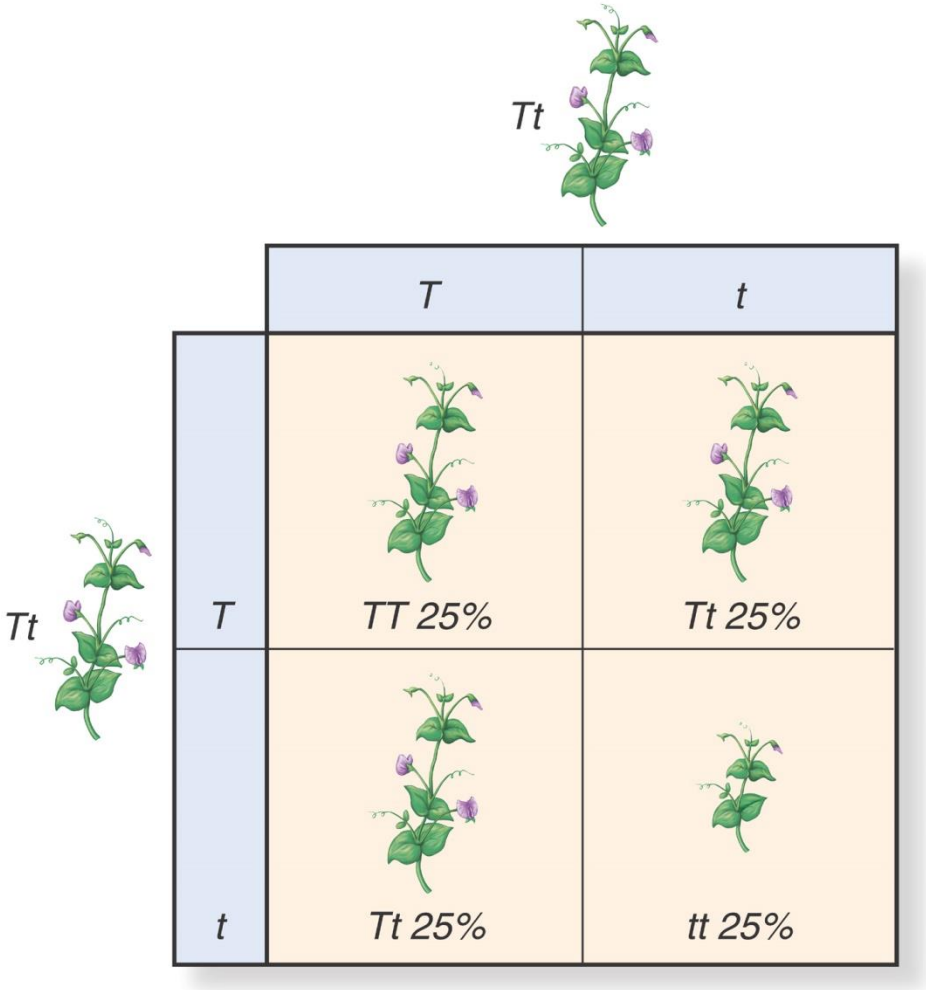
A lowercase letter represents the recessive allele for short.

In this example,

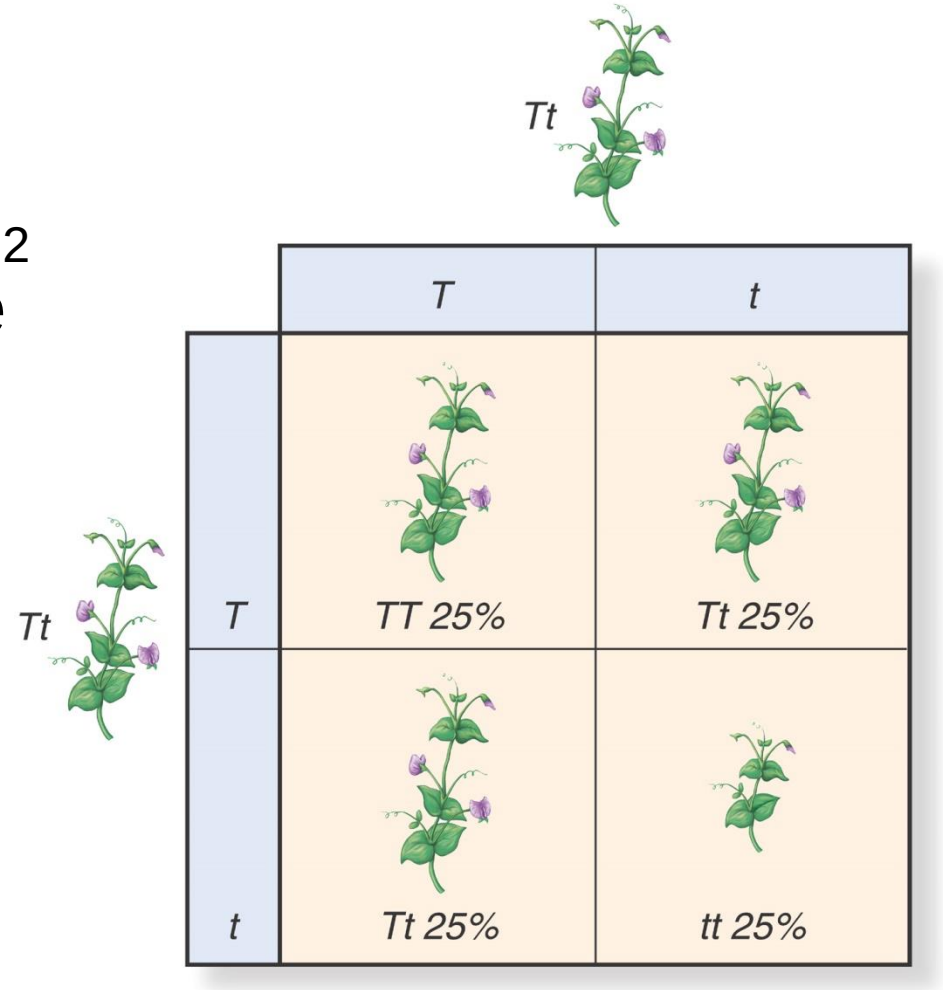
T = tall
t = short



Gametes produced by each F_1 parent are shown along the top and left side.



Possible gene combinations for the F_2 offspring appear in the four boxes.



Organisms that have two identical alleles for a particular trait are said to be **homozygous.**

Organisms that have two different alleles for the same trait are **heterozygous**.

Homozygous organisms are true-breeding for a particular trait.

Heterozygous organisms are hybrid for a particular trait.

All of the tall plants have the same **phenotype**, or physical characteristics.

The tall plants do not have the same **genotype**, or genetic makeup.

One third of the tall plants are *TT*, while two thirds of the tall plants are *Tt.*

The plants have different genotypes (*TT* and *Tt*), but they have the same phenotype (tall).

TT
Homozygous

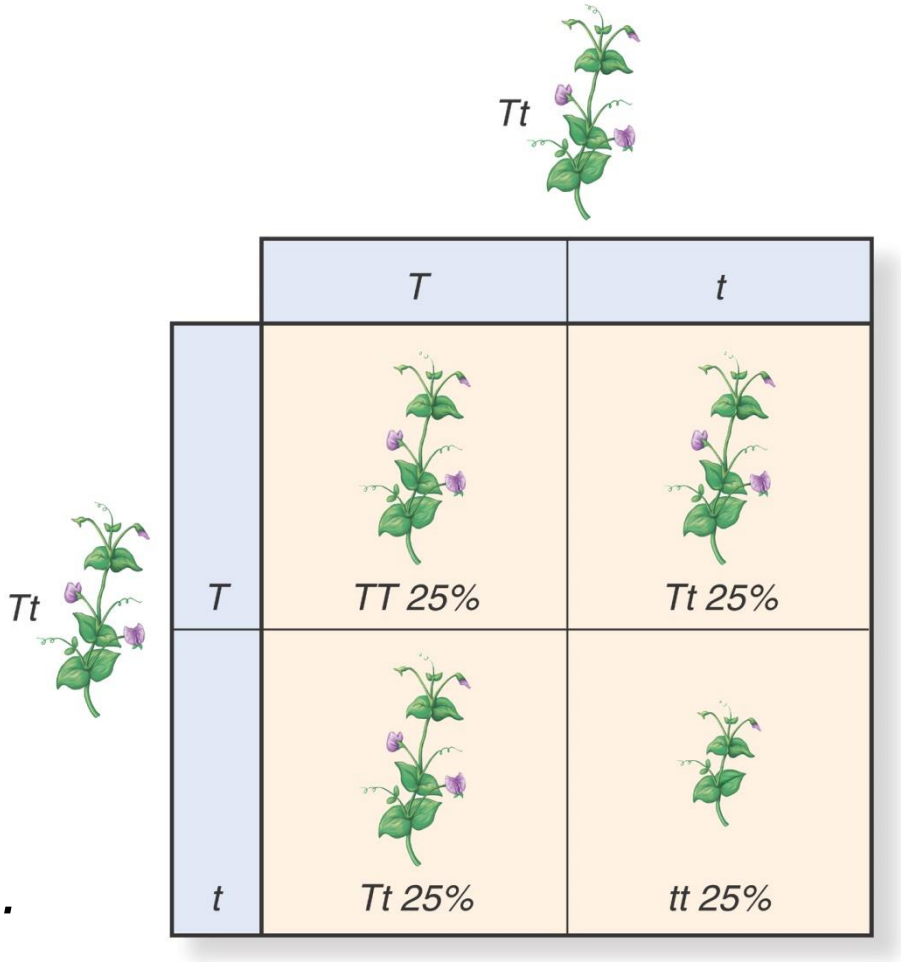
Tt
Heterozygous

Probability and Segregation

One fourth (1/4) of the F_2 plants have two alleles for tallness (*TT*).

2/4 or 1/2 have one allele for tall (*T*), and one for short (*t).*

One fourth (1/4) of the F_2 have two alleles for short *(tt).*



Because the allele for tallness (*T*) is dominant over the allele for shortness (t), 3/4 of the F_2 plants should be tall.

The ratio of tall plants (*TT* or *Tt*) to short *(tt)* plants is 3:1.

The predicted ratio showed up in Mendel's experiments indicating that segregation did occur.

Probabilities Predict Averages

Probabilities predict the average outcome of a large number of events.

Probability cannot predict the precise outcome of an individual event.

In genetics, the larger the number of offspring, the closer the resulting numbers will get to expected values.