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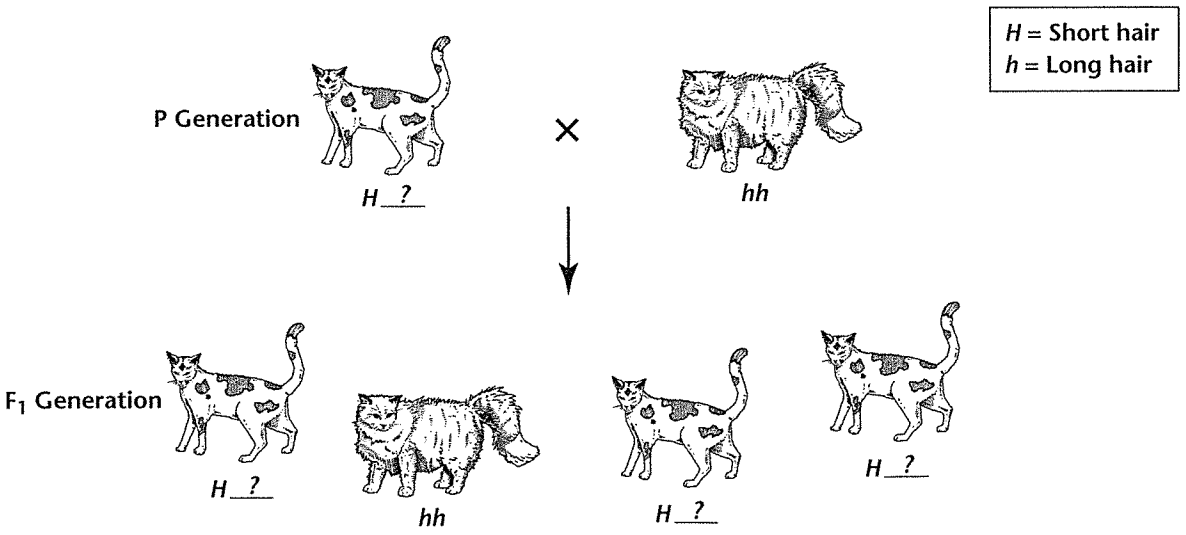
What Is Heredity?

When an organism has a trait controlled by a dominant allele, it can either be a hybrid or a purebred. To find out which, geneticists use a test cross. Read the passage and study the diagram below. Then use a separate sheet of paper to answer the questions that follow the diagram.

The Test Cross

In a test cross, the organism with the trait controlled by a dominant allele is crossed with an organism with a trait controlled by a recessive allele. If all offspring have the trait controlled by the dominant allele, then the parent is probably a purebred. If any offspring has the recessive strait, then the dominant parent is a hybrid.

Test Cross



1. Is the long-haired cat in the P generation a hybrid or a purebred? Explain your answer.
2. Is the short-haired cat in the P generation a hybrid or a purebred? Explain your answer.
3. If the short-haired cat in the P generation were purebred, what would you expect the offspring to look like?
4. In horses, the allele for a black coat (*B*) is dominant over the allele for a brown coat (*b*). A cross between a black horse and a brown horse produces a brown foal. Is the black horse a hybrid or a purebred? Explain.
5. In guinea pigs, the allele for a smooth coat (*S*) is dominant over the allele for a rough coat (*s*). Explain how you could find out whether a guinea pig with a smooth coat is a hybrid or a purebred.

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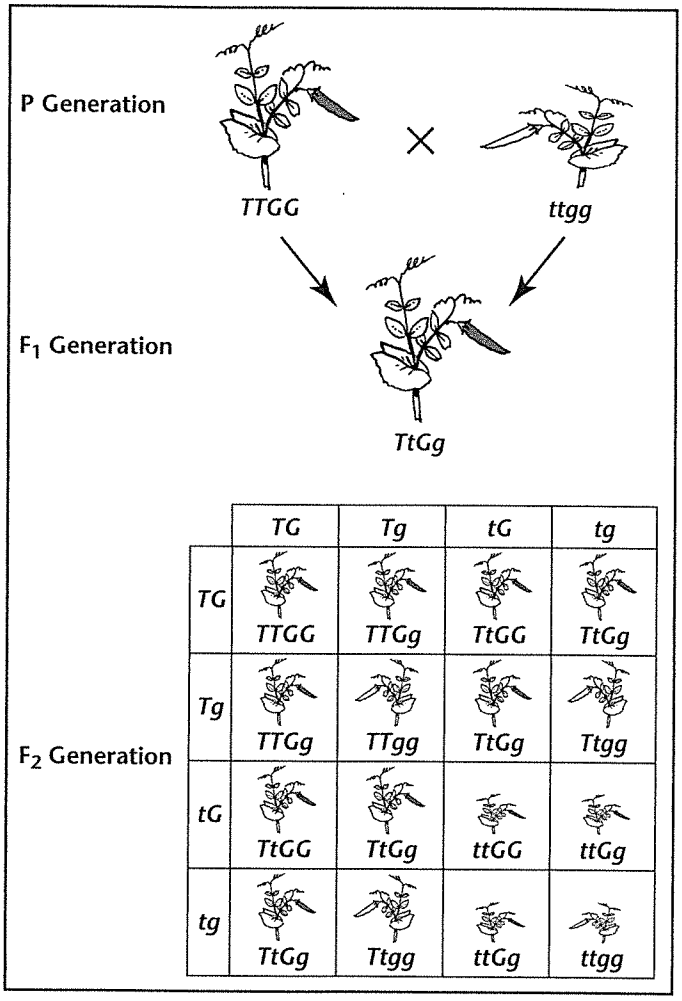
Probability and Heredity

Read the passage and study the diagram to its right. Then use a separate sheet of paper to answer the questions that follow.

Genetic Crosses With Two Traits

In his work with garden peas, Mendel also set up crosses in which he studied the inheritance of two traits at one time. For example, he crossed tall plants having green pods (*TTGG*) with short plants having yellow pods (*ttgg*). The F1 offspring showed both traits controlled by dominant alleles, tall and green. Mendel allowed the F_1 offspring to self-pollinate. The F_2 offspring had four different phenotypes: tall plants with green pods, tall plants with yellow pods, short plants with green pods, and short plants with yellow pods. These results led Mendel to formulate the Law of Independent Assortment, which states that alleles of one gene separate or assort independently of alleles of another gene. In other words, the distribution of one gene does not affect the distribution of alleles for another gene.



	TG	Tg	tG	tg
TG	TTGG	TTGg	TtGG	TtGg
Tg	TTGg	TTgg	TtGg	Ttgg
tG	TtGG	TtGg	ttGG	ttGg
tg	TtGg	Ttgg	ttGg	ttgg

1. What are the possible combinations of alleles that each F_1 parent can pass on to the offspring?
2. What are the possible genotypes of the F_2 offspring? What are the possible phenotypes of the F_2 offspring?
3. What is the probability that an F_2 offspring will be tall with green pods? What is the probability that an F_2 offspring will be short with yellow pods?

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Patterns of Inheritance

Many traits are determined by a combination of more than one gene. Read the passage and study the Punnett square below. Then use a separate sheet of paper to answer the questions that follow the Punnett square.

Polygenic Inheritance

In his genetic experiments with pea plants, Gregor Mendel studied traits that had distinct phenotypes: white or purple flowers, smooth or wrinkled skin, and so on. But many traits found in organisms are more complex and diverse. Humans are not either tall or short; instead, there is a wide range of possible heights—an example of polygenic inheritance. With polygenic inheritance, more than one gene contributes to a phenotype.

To help you understand polygenic inheritance, imagine this simplified scenario: Two genes determine the color of a certain plant's flower. The two genes produce a range of colors from white to red depending on the particular combination of alleles. Red plants are homozygous *AABB* and white plants are homozygous *aabb*. When a white plant is crossed with a red plant, the F_1 offspring have pink flowers (*AaBb*). But what happens when two plants with pink flowers are crossed? The results are shown below.

	AB	***Ab***	***aB***	***ab***
AB	*AABB*	*AABb*	*AaBB*	*AaBb*
Ab	*AABb*	*AAbb*	*AaBb*	*Aabb*
aB	*AaBB*	*AaBb*	*aaBB*	*aaBb*
ab	*AaBb*	*Aabb*	*aaBb*	*aabb*

There are five possible phenotypes in the F_2 offspring, corresponding to the number of dominant alleles in the genotype: red (*AABB*), light red (*AABb, AaBB*), pink (*AbBb, AAbb, aaBB*), light pink (*Aabb, aaBb*), and white (*aabb*).

1. In the example above, can you cross two plants with light-red flowers and get offspring with white flowers? Explain.
2. Imagine that a certain animal's fur length is determined by three genes. The genotype for long fur is *AABBCC* and *aabbcc* for short fur. A cross between long fur and short fur produces F_1 offspring with medium-length fur (*AaBbCc*). Draw a Punnett square that shows a cross between two F_1 offspring.
3. Examine the number of dominant alleles in the genotypes of the F_2 offspring in your Punnett square. How many phenotypes are possible?

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Chromosomes and Inheritance

Follow the procedure below to make a model of meiosis. Then use a separate sheet of paper to answer the questions that follow.

A Model of Meiosis

Materials

different colors of pipe cleaners or yarn
beads
macaroni
string
glue
scissors
marker
construction paper or poster board

Procedure

1. Study the diagram of the stages of meiosis in your textbook.
2. Decide how you can use the materials listed above, or other materials of your choice, to make a model of meiosis. Your model should include the beginning of meiosis, the first division, the second division, and the end of meiosis.
3. Create your model. Begin with at least six copied pairs of chromosomes. Label the stages of meiosis and all the important structures. On a separate sheet of paper, write a description in your own words of what happens in each stage of meiosis.

Analyze and Conclude

1. What is meiosis?
2. What must happen before meiosis can begin?
3. What happens to chromosomes during the first division?
4. What happens to chromosomes during the second division?
5. Compare the sex cells produced by meiosis to the parent cell. Why is the difference between the sex cells and parent cell important?
6. Why are chromosomes important to heredity?