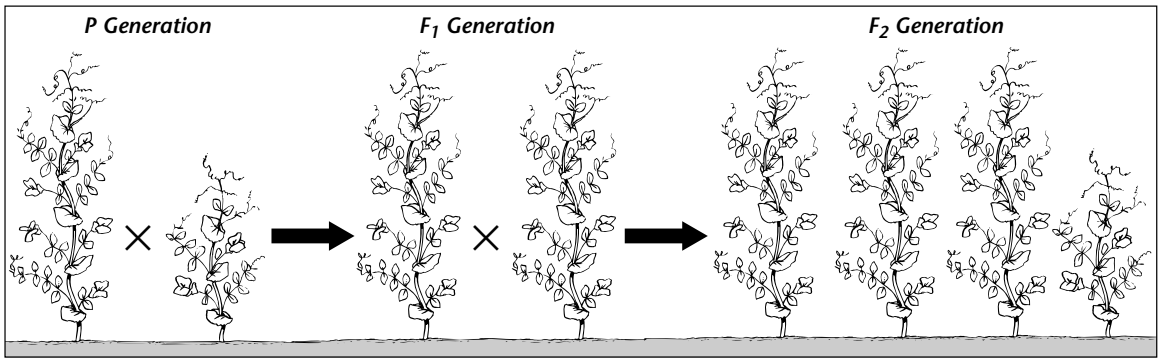
Mendel's Work

Understanding Main Ideas

Study the diagram. Then answer the following questions on a separate sheet of paper.



1. What trait in pea plants is being studied in the cross above?
2. What are the two alleles of this trait?
3. Which allele is the dominant allele? Explain how you know.
4. Which allele is the recessive allele? Explain.
5. What alleles do the F_1 offspring have? Explain which allele was inherited from which parent.

Building Vocabulary

Match each term with its definition by writing the letter of the correct definition on the line beside the term.

____ **6.** genetics

____ **7.** alleles

____ **8.** traits

____ **9.** recessive allele

____ **10.** genes

____ **11.** hybrid

____ **12.** heredity

____ **13.** dominant allele

a. the passing of traits from parents to offspring

b. an organism with two different alleles for a trait

c. factors that control traits

d. physical characteristics of organisms

e. an allele whose trait always shows up in the organism

f. the different forms of a gene

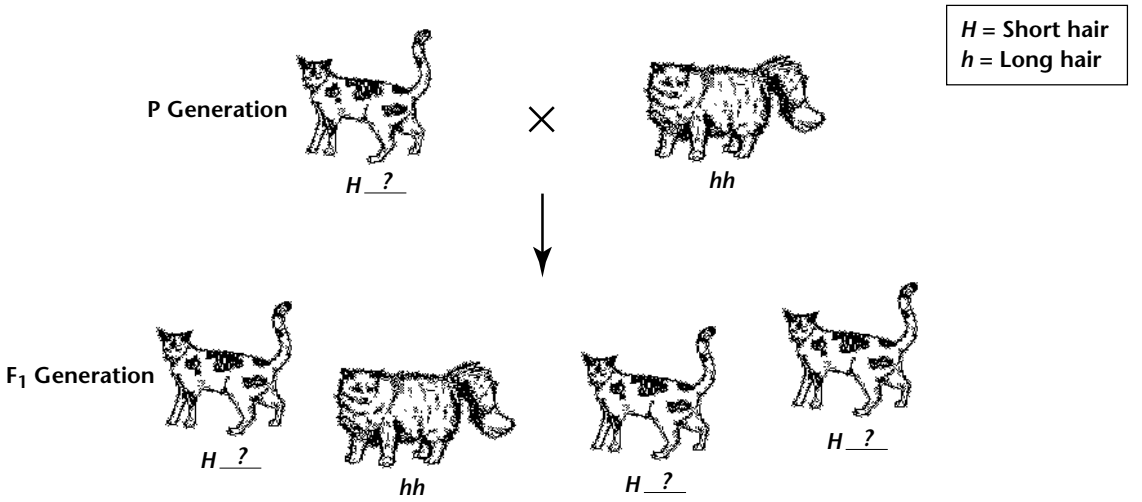
g. the scientific study of heredity

h. an allele whose trait is masked in the presence of a dominant allele

The Test Cross

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 can use a 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 trait, then the dominant parent is a hybrid. Study the test cross below, then answer the questions.

Test Cross



Answer the following questions on a separate sheet of paper.

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.

Probability and Heredity

Understanding Main Ideas

Complete the two Punnett squares below, and then answer the questions on a separate sheet of paper.

1. Punnett Square A:

	B	*b*
B	_____	_____
b	_____	_____

2. Punnett Square B:

	_____	_____
_____	*Bb*	*bb*
_____	*Bb*	*bb*

3. In the cross between two black guinea pigs shown in Punnett Square A, what is the probability that an offspring will be black? White?

4. Is it possible that the cross between two black guinea pigs in Punnett Square A would not produce a white guinea pig? Explain.

5. What color are the guinea pig parents in the cross shown in Punnett Square B?

6. Which guinea pig parent(s) in Punnett Square B is homozygous? Which is heterozygous? Explain how you know.

7. Calculate the probability that an offspring will be black in the cross in Punnett Square B. What is the probability that an offspring will be white?

Building Vocabulary

Match each term with its definition by writing the letter of the correct definition on the line beside the term.

____ **8.** heterozygous

____ **9.** Punnett square

____ **10.** genotype

____ **11.** codominance

____ **12.** probability

____ **13.** homozygous

____ **14.** phenotype

a. a chart that shows all the possible combinations of alleles that can result from a genetic cross

b. a number that describes how likely it is that an event will occur

c. an organism that has two identical alleles for a trait

d. an organism's physical appearance

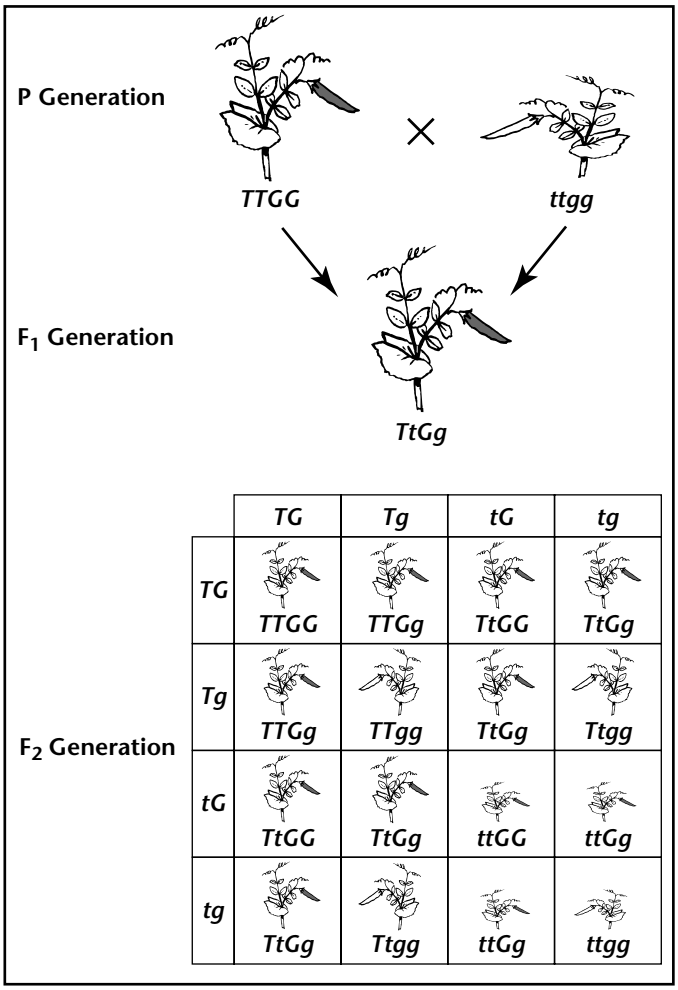
e. an organism's genetic makeup, or allele combinations

f. an organism that has two different alleles for a trait

g. inheritance pattern in which the alleles are neither dominant nor recessive

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 F_1 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 alleles 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

Study the Punnett square of a genetic cross between two pea plants with two different traits. Then answer the questions that follow.

Answer the following questions on a separate sheet of paper.

1. What are all 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?

The Cell and Inheritance

Understanding Main Ideas

Complete the table below by filling in the spaces with the correct stage of meiosis—Beginning, Meiosis I, Meiosis II, End.

Event	Stage in Meiosis
The double-stranded chromosomes move to the center of the cell. The centromeres separate.	**1.** _____
Two cells form, each with half the number of chromosomes. Each chromosome still has two chromatids.	**2.** _____
Four sex cells form with half the number of chromosomes as the parental cells.	**3.** _____
The chromosomes are copied.	**4.** _____

Answer the following questions in the spaces provided.

5. What is the chromosome theory of inheritance?

_____

_____

6. Why is it important that sex cells have half the number of chromosomes as body cells?

_____

_____

_____

_____

_____

Building Vocabulary

Fill in the blank to complete the statement.

7. The process by which the number of chromosomes is reduced by half to form sex cells is called _____.

A Model of Meiosis

Follow the procedure below to make 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, meiosis I, meiosis II, 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

Answer the following questions on a separate sheet of paper.

1. What is meiosis?
2. What must happen before meiosis can begin?
3. What happens to chromosomes during meiosis I?
4. What happens to chromosomes during meiosis II?
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?

Genes, DNA, and Proteins

Understanding Main Ideas

Complete the table below by stating whether each mutation is helpful, harmful, or neutral to the organism.

Mutation	Effect
White lemur (in a zoo)	**1.** _____
White lemur (in the wild)	**2.** _____
Antibiotic resistance in bacteria	**3.** _____

Answer the following questions on the lines provided.

4. Describe what occurs during protein synthesis.

_____

_____

_____

_____

_____

_____

5. What is the genetic code?

_____

_____

_____

Building Vocabulary

Fill in the blank to complete each statement.

6. A _____ is any change in a gene or chromosome.

7. A type of RNA that carries amino acids and adds them to the growing protein is called _____ .

8. _____ is RNA that copies the coded message from the DNA in the nucleus and carries the message into the cytoplasm.

The Genetic Code

The genetic code is made up of groups of three nitrogen bases in the messenger RNA. Each three-base group, called a **codon,** codes for one amino acid. The table below shows the genetic code. To find the amino acid that is coded for by the codon UGG in messenger RNA, look in the row of the first base in the codon—U. Then move to the box that is specified by the second base in the codon—G. Finally, look down the list of amino acids in the box until you find the one in row "G," the third base in the codon. You should find that UGG is the codon for tryptophan.

Transfer RNA matches up with the messenger RNA at the ribosome to deliver the correct amino acid to the growing protein chain. Transfer RNA has a three-base code called an **anticodon** that matches up with the codon in the messenger RNA.

Answer the following questions on a separate sheet of paper.

The Genetic Code (messenger RNA)

First Base in Codon	A	G	U	C	Third Base in Codon
A	Lysine Lysine Asparagine Asparagine	Arginine Arginine Serine Serine	Isoleucine Methionine Isoleucine Isoleucine	Threonine Threonine Threonine Threonine	A G U C
G	Glutamic acid Glutamic acid Aspartic acid Aspartic acid	Glycine Glycine Glycine Glycine	Valine Valine Valine Valine	Alanine Alanine Alanine Alanine	A G U C
U	"Stop" codon "Stop" codon Tyrosine Tyrosine	"Stop" codon Tryptophan Cysteine Cysteine	Leucine Leucine Phenylanaline Phenylanaline	Serine Serine Serine Serine	A G U C
C	Glutamine Glutamine Histidine Histidine	Arginine Arginine Arginine Arginine	Leucine Leucine Leucine Leucine	Proline Proline Proline Proline	A G U C

Second Base in Codon

1. If the DNA sequence of a gene was TACTTACCGAGC TAGACT, then what is the sequence of the messenger RNA?
2. Use the genetic code to identify the sequence of amino acids encoded by the messenger RNA that you identified in Question 1.
3. What are the sequences of the anticodons for the transfer RNA molecules that carry each of the amino acids in the protein sequence that you identified in Question 2?
4. How would the protein change if a mutation caused a base to be added, making the mutated DNA sequence TACGTTACCGAGCTAGACT? How is the protein affected by this mutation? (*Hint:* How does the extra letter change the series of bases?)
5. How would the protein change if a mutation caused one base to replace another, making the mutated DNA sequence TACTTACCTAGCTAGACT? How does this mutation affect protein function?