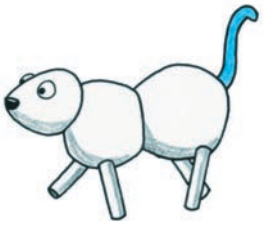
5 Gene Squares

PROBLEM SOLVING

JOE WONDERS WHAT *chances he would have of transmitting Marfan syndrome to his children someday if he does have the gene. He asks the genetic counselor for help. She shows him a model to help him figure out the chances but cautions him that the model predicts only what is likely to happen, not what will happen.*

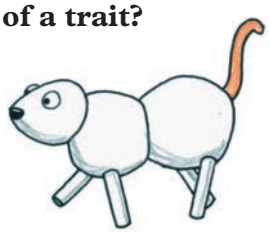
In previous activities, you learned that each offspring receives half of its genes from one parent and half from the other parent. You also learned that different versions of a gene are called alleles. You used coin tosses to model the way alleles are passed from parents to offspring. You observed that each offspring received two alleles, one from each parent. In the simulation to determine tail color, if one parent contributed a blue tail-color allele (**T**) and the other parent contributed an orange tail-color allele (**t**), the allele combination was **Tt**. This is a critter's **genotype** (GEEN-oh-type) for that characteristic. Because the allele for the blue tail color was dominant, the **Tt** combination caused the physical appearance of the tail to be blue. We call the critter's physical appearance its **phenotype** (FEEN-oh-type) for the characteristic.

In this activity, you will learn how a table, called a *Punnett (PUN-it) square*, can help you model and predict the genotypes and phenotypes of offspring.



GUIDING QUESTION

How can we model and predict the ratios of traits observed in the offspring of parents with two versions of a trait?



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MATERIALS

For each student

1 Student Sheet 5.1, "Punnett Squares—Step by Step"

PROCEDURE

Read "How to Use Punnett Squares."

a. Work with your group to prepare a short summary that describes how Punnett Squares model the results of sexual reproduction.

b. Complete the Punnett squares on Student Sheet 5.1 "Punnett Squares—Step by Step."

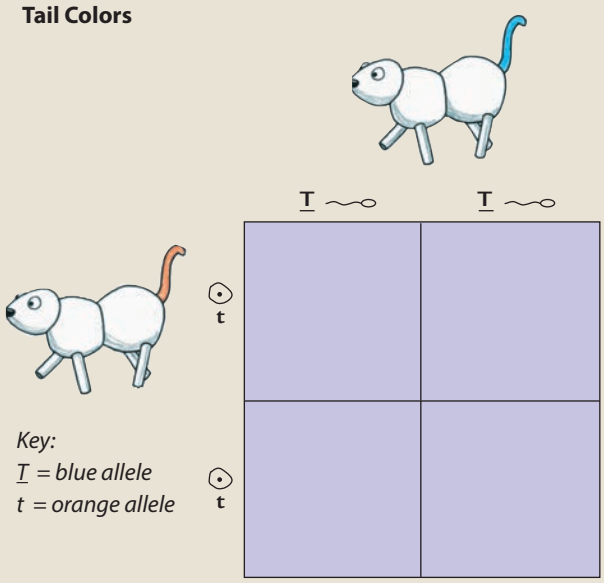
HOW TO USE PUNNETT SQUARES

Background

A **Punnett square** is a diagram you can use to show the likelihood of each outcome of a breeding experiment. It is used when each parent's genes for a trait are known. By filling in the squares, you can find the possible genotypes and phenotypes of the offspring. You can also predict the chances that each phenotype will occur in the offspring.

Consider the cross between Skye and Poppy as an example. The two phenotypes for tail color are blue and orange. As you modeled with colored disks in "Creature Features," there are two versions of the tail-color gene, one for blue and one for orange. These two versions are called alleles. As you saw when you did the coin tosses in "Gene Combo," the blue allele can be represented as uppercase **T** and the orange allele as lowercase **t**. The uppercase letter represents the dominant trait. (You might also use **B** for blue and **b** for orange, since blue is the dominant trait. But you need to use the same letter, uppercase and lowercase, for the two alleles of any one gene. To avoid confusion, always remember to underline the uppercase letter.)

Because Skye is from an island where there are no orange-tailed critters, we can assume he has only blue tail-color alleles. So, his genotype for tail color is **TT**. Because Poppy is from an island where there are no blue-tailed critters, we can assume she has only orange tail-color alleles. So, her genotype for tail color is **tt**. An organism that has only one kind of allele for a characteristic is called **homozygous**. Skye is homozygous for the blue tail-color trait, while Poppy is homozygous for the orange tail-color trait.

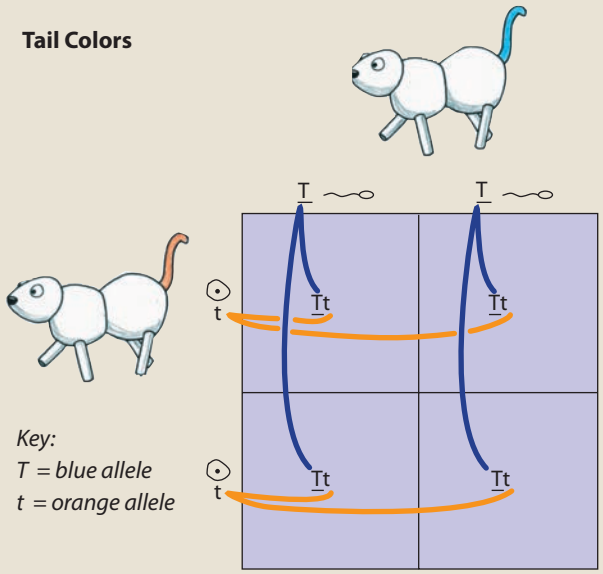


Step 1: Starting a Punnett Square

Every Punnett square should have a title, four boxes, the genotypes of one parent's traits listed along the top and the other parent's traits listed along at the left of the square, and a key.

Write the possible alleles donated by each parent along the top of the table and left side of the table—it doesn't matter which parent you use for each position. In the top left table shown above, Skye's alleles are placed along the top and Poppy's at the left.

Each **T** along the top represents an allele in the sperm cell produced by Skye. Each **t** on the left represents an allele in the egg cell from Poppy.



Step 2: Completing a Punnett Square

Complete each box of the table by combining one allele from the top and one allele from the left, as shown in the bottom left table.

When you combine one allele from each parent into a box, you are representing a sperm cell fertilizing an egg.

Step 3: Making Conclusions Using a Punnett Square

Now you can use the Punnett square to make some predictions. All of Skye and Poppy's offspring will have one allele for blue tail color and one allele for orange tail color. Their genotypes will be **Tt**. An organism that has alleles for two different tail-color traits is called **heterozygous.** Because blue tail color is dominant over orange, the phenotype of all offspring is blue tails, as found in the breeding experiment between Skye and Poppy.

Remember: An underlined uppercase letter is used for the allele for the dominant trait; a lowercase letter is used for the allele for the recessive trait.

Name_____ Date_____

STUDENT SHEET 5.1

PUNNETT SQUARES—STEP BY STEP

The cross between the Generation 2 (Tt) critters Ocean and Lucy is:

Ocean x Lucy

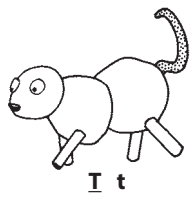
Tt x Tt

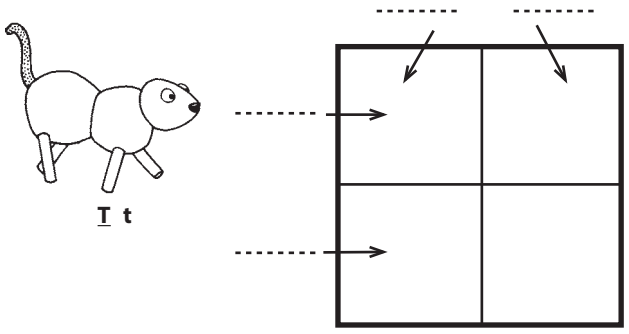
T = allele for blue tail color (dominant)
t = allele for orange tail color (recessive)

Note that while Ocean and Lucy both have blue tails, they are both heterozygous.

1. **Referring to the example above from your book, complete this Punnett square for the cross between Ocean and Lucy.**
   a. **Place Ocean's and Lucy's alleles on the dotted lines in the Punnett square.**
   b. **Complete the Punnett square by filling in each box with the allele above it and the allele to its left.**

Tail Color





Key:

T = _____

t = _____

   c. **Use either a blue pencil or a regular pencil to shade in the squares for offspring that will have blue tails in your Punnett square above.**
   d. **About what fraction of the offspring of Ocean and Lucy are predicted to have blue tails, according to the Punnett square?**
   e. **About what fraction are predicted to have orange tails?**

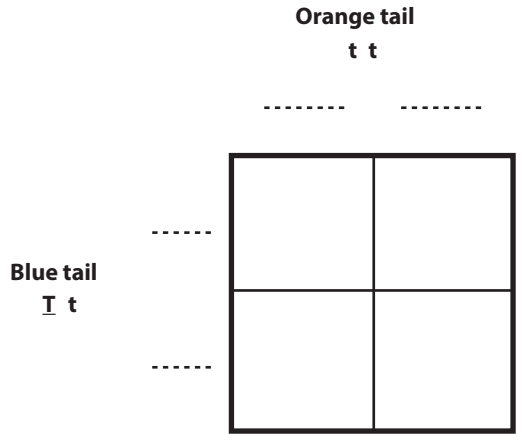
STUDENT SHEET 5.1

PUNNETT SQUARES—STEP BY STEP (CONTINUED)

Generation 3 includes some critters with orange tails and some with blue tails.

2. Complete this Punnett square for a cross between an orange-tailed critter and a heterozygous blue-tailed (Tt) critter.

Tail Color



Key:

T = _____

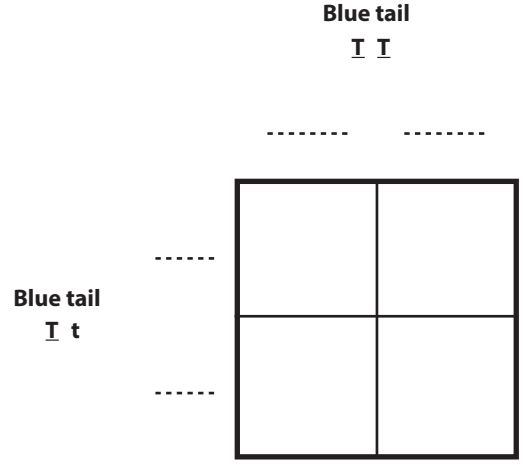
t = _____

a. Use pencil to shade in the squares for offspring with blue tails.

b. About what fraction of the offspring are predicted to have blue tails?

c. About what fraction are predicted to have orange tails?

Tail Color



Key:

T = _____

t = _____

3. Complete this Punnett square for a cross between a homozygous blue critter (TT) critter and a heterozygous blue-tailed (Tt) critter

a. Use pencil to shade in the squares for offspring with blue tails.

b. About what fraction of the offspring are predicted to have blue tails?

c. About what fraction are predicted to have orange tails?

Genetics Worksheet

Name: _____

Genetics Practice Problems - Simple Worksheet

1. For each genotype below, indicate whether it is heterozygous (**He**) or homozygous (**Ho**)

AA _____	Ee _____	Ii _____	Mm _____
Bb _____	ff _____	Jj _____	nn _____
Cc _____	Gg _____	kk _____	oo _____
DD _____	HH _____	LL _____	Pp _____

2. For each of the **genotypes** below determine what **phenotypes** would be possible.

Purple flowers are dominant to white flowers.

PP_____

Pp_____

pp_____

Bobtails in cats are recessive.

TT _____

Tt _____

tt_____

Brown eyes are dominant to blue eyes

BB_____

Bb_____

bb_____

Round seeds are dominant to wrinkled seeds

RR_____

Rr_____

rr _____

Name: _____

Genetics Worksheet

3. For each **phenotype** below, list the **genotypes** (remember to use the letter of the dominant trait)

Straight hair is dominant to curly.

____ straight

_____ curly

Pointed heads are dominant to round heads.

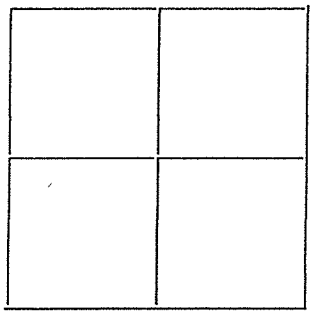
_____ pointed

_____ round

4. Set up the Punnet squares for each of the crosses listed below.

Round seeds are dominant to wrinkled seeds.

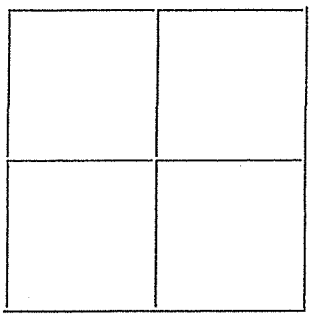
RR x rr



What percentage of the offspring will be round?

_____

Rr x rr



What percent of the offspring will be round?

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