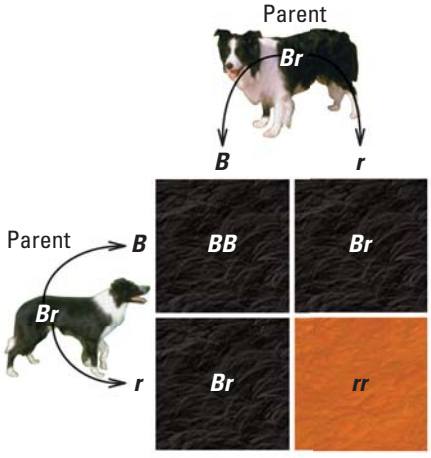
EXAMPLE 4 TAKS REASONING: Multi-Step Problem

BORDER COLLIES The color of the dark patches of a border collie's coat is determined by a combination of two genes. An offspring inherits one patch color gene from each parent. Each parent has two color genes, and the offspring has an equal chance of inheriting either one.

The gene B is for black patches, and the gene r is for red patches. Any gene combination with a B results in black patches. Suppose each parent has the same gene combination Br. The Punnett square shows the possible gene combinations of the offspring and the resulting patch color.



- What percent of the possible gene combinations of the offspring result in black patches?
- Show how you could use a polynomial to model the possible gene combinations of the offspring.

Solution

STEP 1 **Notice** that the Punnett square shows 4 possible gene combinations of the offspring. Of these combinations, 3 result in black patches.

▶ 75% of the possible gene combinations result in black patches.

STEP 2 **Model** the gene from each parent with $0.5B + 0.5r$. There is an equal chance that the collie inherits a black or red gene from each parent.

The possible genes of the offspring can be modeled by $(0.5B + 0.5r)^2$. Notice that this product also represents the area of the Punnett square.

Expand the product to find the possible patch colors of the offspring.

$$(0.5B + 0.5r)^2 = (0.5B)^2 + 2(0.5B)(0.5r) + (0.5r)^2$$
$$= 0.25B^2 + 0.5Br + 0.25r^2$$

Consider the coefficients in the polynomial.

$$0.25B^2 + 0.5Br + 0.25r^2$$

25% *BB*, black patches — 50% *Br*, black patches — 25% *rr*, red patches

The coefficients show that 25% + 50% = 75% of the possible gene combinations will result in black patches.

GUIDED PRACTICE for Examples 3 and 4

8. *Describe* how you can use special products to find 21^2.

9. **BORDER COLLIES** Look back at Example 4. What percent of the possible gene combinations of the offspring result in red patches?