

To use this gene mapping activity, print out as many dogs as needed to give one to each student. (Cut along dotted lines to produce 4 dog handouts per page.)

It is important that the relative ratios of the 8 different dogs are largely maintained. For example, for 16 students, print two copies of page one and two copies of page two rather than four copies of page one.



Gene	1	2	3	4	5
Genotype	aa	AA	AA	Aa	AA



Gene	1	2	3	4	5
Genotype	AA	Aa	AA	aa	AA



Gene	1	2	3	4	5
Genotype	Aa	aa	Aa	AA	Aa



Gene	1	2	3	4	5
Genotype	AA	aa	Aa	aa	Aa



Gene	1	2	3	4	5
Genotype	AA	aa	AA	AA	aa



Gene	1	2	3	4	5
Genotype	aa	aa	Aa	aa	aa



Gene	1	2	3	4	5
Genotype	aa	Aa	AA	Aa	aa



Gene	1	2	3	4	5
Genotype	AA	AA	aa	aa	aa

## Gene mapping in dogs (Instructor guide)

*designed for groups of ~15 (up to 16) students*

### **Preparation:**

Give each student a paper with a dog and a genotype.

### **Background information to read to students:**

We are a group of scientists trying to find the gene responsible for **an orange spot** in dogs. Dogs are diploid just like humans, which means that they have two copies (alleles) of each gene. For this exercise, the dominant allele is indicated by “A” and the recessive allele is indicated by “a”.

Pretend that each of you extracted DNA from the dog shown in your picture, and then sequenced the DNA to determine the genotype for each of five genes. For each gene, you used these sequences to determine the genotype, which can be either AA, Aa, or aa.

### **Brainstorming:**

“Working together as a group, how can we figure out which gene controls **whether or not a dog has an orange spot?**”

*Answer: compare the genotypes and phenotypes to find a gene whose genotype explains the phenotype.*

*After giving the students some time to think about the problem on their own, you can divide them into two groups based on the phenotype (e.g., with spots and without spots). This should help them start to look for a gene where everyone with the same phenotype has the same genotype.*

“Once the gene has been identified, how can we figure out which phenotype (**spot or no spot**) is caused by the dominant allele?”

*Answer: look at the phenotype of a dog with the heterozygous (Aa) genotype for the responsible gene.*

***If the students haven't solved the problem on their own after brainstorming, you can use the guided solution on the back of this page.***

### Guided solution

Physically divide the students into two groups: one with spots, one with no spots. For example, ask all the students whose dog has an orange spot to move to your left and all students whose dog does not have an orange spot to move to your right.

Use a show of hands to determine the number of students with each genotype/phenotype combination. For example, ask students in the spotted dog group: For Gene 1, who has at least one A allele (that is, genotype AA or Aa)? Repeat with all genotype/phenotype combinations and **record the counts** in the table below for each gene. You count students with the AA and Aa genotypes together because the A allele is completely dominant so that they have the same phenotype.

Gene 1	AA or Aa	aa
Spot		
No spot		

Gene 2	AA or Aa	aa
Spot		
No spot		

Gene 3	AA or Aa	aa
Spot		
No spot		

Gene 4	AA or Aa	aa
Spot		
No spot		

Gene 5	AA or Aa	aa
Spot		
No spot		

Use these data to find the gene you think is most likely responsible. Time permitting, ask which allele they think is dominant by looking at the dog(s) with the Aa genotype for the responsible gene.

*Answers: Gene 5 is responsible, "No spot" allele is dominant*

## Gene mapping in dogs (Instructor guide)

*designed for groups of ~15 (up to 16) students*

### **Preparation:**

Give each student a paper with a dog and a genotype.

### **Background information to read to students:**

“We are a group of scientists trying to find the gene responsible for **body size** in dogs. Dogs are diploid just like humans, which means that they have two copies (alleles) of each gene. For this exercise, the dominant allele is indicated by “A” and the recessive allele is indicated by “a”.

Pretend that each of you extracted DNA from the dog shown in your picture, and then sequenced the DNA to determine the genotype for each of five genes. For each gene, you used these sequences to determine the genotype, which can be either AA, Aa, or aa.”

### **Brainstorming**

“Working together as a group, how can we figure out which gene controls **body size**?”

*Answer: compare the genotypes and phenotypes to find a gene whose genotype explains the phenotype.*

*After giving the students some time to think about the problem on their own, you can divide them into two groups based on the phenotype (e.g., big dogs and small dogs). This should help them start to look for a gene where everyone with the same phenotype has the same genotype.*

“Once the gene has been identified, how can we figure out which phenotype (**big or small**) is caused by the dominant allele?”

*Answer: look at the phenotype of a dog with the heterozygous (Aa) genotype for the responsible gene.*

***If the students haven't solved the problem on their own after brainstorming, you can use the guided solution on the back of this page.***

**Guided solution:**

Physically divide the students into two groups: one with big dogs, one with small dogs. For example, ask all the students with a big dog to move to your left and all students with a small dog to move to your right.

Use a show of hands to determine the number of students with each genotype/phenotype combination. For example, ask students in the big dog group: For Gene 1, who has at least one A allele (that is, genotype AA or Aa)? Repeat with all genotype/phenotype combinations and **record the counts** in the table below for each gene. You count students with the AA and Aa genotypes together because the A allele is completely dominant so that they have the same phenotype.

Gene 1	AA or Aa	aa
Big dog		
Small dog		

Gene 2	AA or Aa	aa
Big dog		
Small dog		

Gene 3	AA or Aa	aa
Big dog		
Small dog		

Gene 4	AA or Aa	aa
Big dog		
Small dog		

Gene 5	AA or Aa	aa
Big dog		
Small dog		

Use these data to find the gene you think is most likely responsible. Time permitting, ask which allele they think is dominant by looking at the dog(s) with the Aa genotype for the responsible gene.

*Answer: Gene 4 is responsible, "big" allele is dominant*

## Gene mapping in dogs (Instructor guide)

*designed for groups of ~15 (up to 16) students*

### **Preparation:**

Give each student a paper with a dog and a genotype.

### **Background information to read to students:**

“We are a group of scientists trying to find the gene responsible for **coat color** in dogs. Dogs are diploid just like humans, which means that they have two copies (alleles) of each gene. For this exercise, the dominant allele is indicated by “A” and the recessive allele is indicated by “a”.

Pretend that each of you extracted DNA from the dog shown in your picture, and then sequenced the DNA to determine the genotype for each of five genes. For each gene, you used these sequences to determine the genotype, which can be either AA, Aa, or aa.”

### **Brainstorming:**

“Working together as a group, how can we figure out which gene controls **coat color**?”

*Answer: compare the genotypes and phenotypes to find a gene whose genotype explains the phenotype.*

*After giving the students some time to think about the problem on their own, you can divide them into two groups based on the phenotype (e.g., black dogs and white dogs). This should help them start to look for a gene where everyone with the same phenotype has the same genotype.*

“Once the gene has been identified, how can we figure out which phenotype (**black or white**) is caused by the dominant allele?”

*Answer: look at the phenotype of a dog with the heterozygous (Aa) genotype for the responsible gene.*

***If the students haven't solved the problem on their own after brainstorming, you can use the guided solution on the back of this page.***

### Guided solution

Physically divide the students into two groups: one with black dogs, one with white dogs. For example, ask all the students with a black dog to move to your left and all students with a white dog to move to your right.

Use a show of hands to determine the number of students with each genotype/phenotype combination. For example, ask students in the black dog group: For Gene 1, who has at least one A allele (that is, genotype AA or Aa)? Repeat with all genotype/phenotype combinations and **record the counts** in the table below for each gene. You count students with the AA and Aa genotypes together because the A allele is completely dominant so that they have the same phenotype.

Gene 1	AA or Aa	aa
Black dog		
White dog		

Gene 2	AA or Aa	aa
Black dog		
White dog		

Gene 3	AA or Aa	aa
Black dog		
White dog		

Gene 4	AA or Aa	aa
Black dog		
White dog		

Gene 5	AA or Aa	aa
Black dog		
White dog		

Use these data to find the gene you think is most likely responsible. Time permitting, ask which allele they think is dominant by looking at the dog(s) with the Aa genotype for the responsible gene.

*Answers: Gene 2, "White" allele is dominant*