Dye Electrophoresis Lab

Cat Genetics

miniPCR bio Learning Lab™
Dye Electrophoresis Lab:
Cat Genetics

Version: 1.0
Release: November 2022

Contents

At a glance

This miniPCR bio Learning Lab™ was created to give beginner students hands-on experience with biotechnology. The use of safe and affordable dyes to simulate DNA samples makes it easier than ever to bring gel electrophoresis to your classroom!

Lab overview

Use genetics to examine the link between genotype and phenotype in a family of cats!

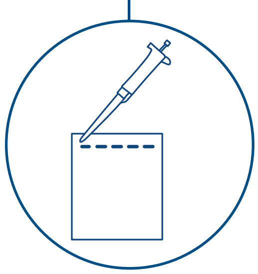
This lab connects traditional Mendelian genetics with our modern understanding of DNA and inheritance. Students will first examine a family of cats to track the inheritance of a single trait using Punnett squares. Then, they will use gel electrophoresis to analyze simulated DNA samples to examine how genetic differences control that trait.

TECHNIQUES	TOPICS	LEVEL	WHAT YOU NEED
Micropipetting Gel electrophoresis	Genotype to phenotype Mendelian inheritance Biotechnology	Middle school General high school	Micropipette Gel electrophoresis system

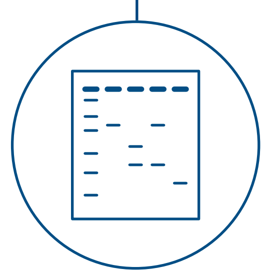
Planning your time

SINGLE CLASS PERIOD: 45 MINUTES if gels are prepared in advance

Gel electrophoresis



Interpret results



Additional supports

Help your students build proficiency in pipetting and gel electrophoresis with additional instructional videos, worksheets, and activities available at: https://www.minipcr.com/tutorials/

For answers to the lab study questions, email answers@minipcr.com. Please include the name of the lab, as well as your name, school, and title in the body of the email.

Materials needed

Supplied in kit (KT-1402-01)

Reagents and supplies	Amount provided in kit	Amount needed per lab group	Storage	Teacher's checklist
Blue dye samples	**8 Load Ready™ Strips**	**1 Load Ready™ Strip**	Refrigerator	
Agarose Tabs™	**8 Tabs**	**1 Tab** per gel (if using a Bandit™ or blueGel™ electrophoresis system)	Room temp.	
TBE buffer	**Supplied as powder** Sufficient to prepare 600 ml	**60 ml** per gel (if using a Bandit™ or blueGel™ electrophoresis system)	Room temp.	

Supplied by teacher

Available at minipcr.com:

Reagents and supplies	Amount needed per lab group	Teacher's checklist
Horizontal gel electrophoresis apparatus *e.g.*, Bandit™ STEM electrophoresis kit (QP-1400-01) or blueGel™ electrophoresis system (QP-1500-01)	1	
Micropipettes 2-20 µl adjustable volume (QP-1001-01) or 10 µl fixed volume (QP-1003-02)	1	
Disposable 2-200 µl micropipette tips (CM-1001-10 or CM-1001-01)	**At least 6**	
Distilled water for making agarose gels and preparing TBE buffer	**600 ml total**	
Flask or beaker to prepare TBE buffer and dissolve Agarose Tabs™		
Screw top bottle to store prepared TBE buffer		
Microwave or hot plate to dissolve Agarose Tabs™		
Other supplies: • Disposable laboratory gloves • Protective eyewear • Permanent marker • Cup to dispose of tips		

Lab setup

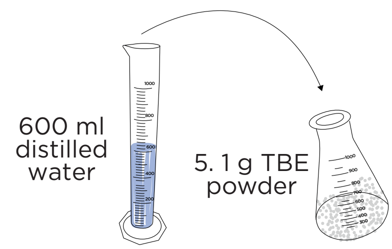
• The following activities can be carried out by the instructor ahead of class.
• Reagents are sufficient to be used with 8 student groups.
• Reagents are stable at room temperature.

Gloves and protective eyewear should be worn for the entirety of this lab.

A. Prepare TBE buffer

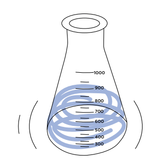
1. Combine TBE powder and 600 ml distilled water

- Obtain a heat resistant container such as a glass Erlenmeyer flask or beaker that is at least 1 L in volume.
- The lab kit comes with a pouch of TBE powder. Empty entire container of TBE powder (5.1 g) into the flask or beaker.
- Add 600 ml distilled water.



2. Dissolve TBE powder

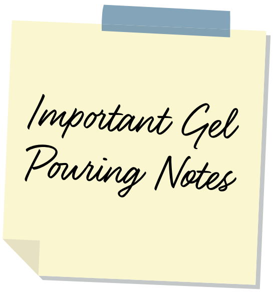
- Stir or intermittently shake solution until TBE powder is dissolved (this may take up to 10-15 minutes).
- You may warm as necessary to help dissolve the powder.
- It is normal for a small amount of powder to remain undissolved after 15 minutes. Small amounts of undissolved powder will not affect performance.


10-15 minutes

3. Store prepared TBE buffer

- TBE buffer can be stored in an airtight container at room temperature for at least three months.
- Discard unused TBE buffer if it becomes cloudy.

B. Make gels

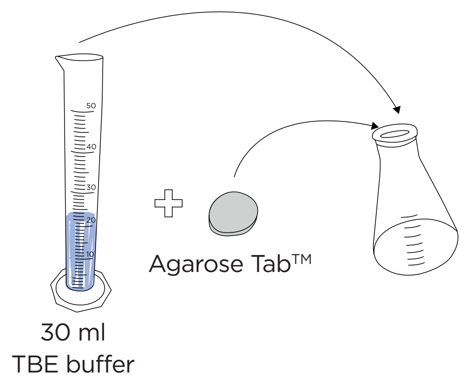


- Gels can be prepared up to five days ahead of time. Store in an airtight container at room temperature.
- These instructions are designed for use with the pre-weighed Agarose Tabs™ provided in the lab kit.
- One Agarose Tab™ will yield one gel for use in either a Bandit™ or blueGel™ electrophoresis system by miniPCR bio™.
- If using a different electrophoresis system, these instructions may need to be adjusted according to the manufacturer's instructions. Each tab contains 0.5 g of agarose, and you can use gels of any percentage between 1-2%.

See detailed assembly and gel pouring instructions for the Bandit™ STEM Electrophoresis Kit https://www.minipcr.com/bandit-assembly/

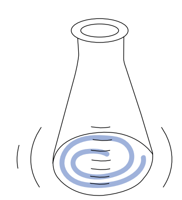
1. Prepare an agarose solution

- Obtain a heat-resistant container such as a glass Erlenmeyer flask or beaker that holds at least three times the volume you wish to add.
- Combine 30 ml room temperature TBE buffer and one Agarose Tab™ for each gel you plan use in a Bandit™ or blueGel™ electrophoresis system.
- Allow the tabs to soak until they fully disintegrate (this might take a few minutes).
- Swirl the flask or beaker to ensure the tabs have fully disintegrated before heating.



2. Heat solution

- Expect to heat for about 60 seconds per 30 ml of liquid in a standard microwave.
- Heat until the solution boils and continue until agarose is fully dissolved. No agarose particles should remain.

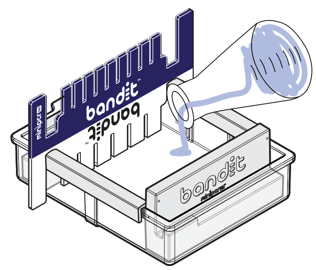


Caution: The solution may boil over the top of some containers. The solution will be very hot.

3. Set up your gel casting system

- You will need six lanes per gel.
- If using a Bandit™ STEM electrophoresis kit:
  - Make sure Electrodams™ are firmly in place before pouring gel.
  - Place the comb approximately 1 cm from the black Electrodam™.

4. Pour the agarose solution into the prepared casting platform with a gel tray and comb

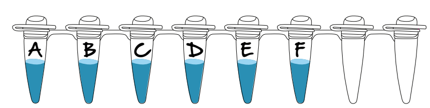


- The agarose solution should cover the bottom of the gel tray and the bottom 3 mm of the comb (roughly the bottom 1/3 of the comb).
- Note: Because this lab uses colored dyes as experimental samples, there is no need to add DNA stain.

5. Allow gel to solidify completely

- Gel is ready when cool and firm to the touch, which typically takes about 10 minutes.
- Gels can be stored in an airtight container at room temperature for five days before use.
- You can remove the comb and disassemble the gel casting apparatus before storing the gel.

C. Label Load Ready™ Strips



- On each Load Ready™ Strip, label the tubes containing blue dye A-F. There should be two empty tubes after tube F.
- Alternatively, have students label the tubes when they receive their Load Ready™ Strip.
- Note: If Load Ready™ Strips were stored at room temperature instead of in the refrigerator, evaporation may occur. Each tube should have at least 20 µl of dye. If significant evaporation has occurred, dye samples may become viscous and can be difficult to pipette. If this is the case, you can add 10 µl of distilled water to each sample.

D. Distribute supplies and reagents to lab groups

CHECK	At the start of this experiment, every lab group should have:	Amount
	Load Ready™ Strip containing blue dye samples	1
	2-20 µl micropipette or 10 µl fixed volume micropipette	1
	Micropipette tips	At least 6
	Six wells in an electrophoresis gel	

Reducing plastic waste

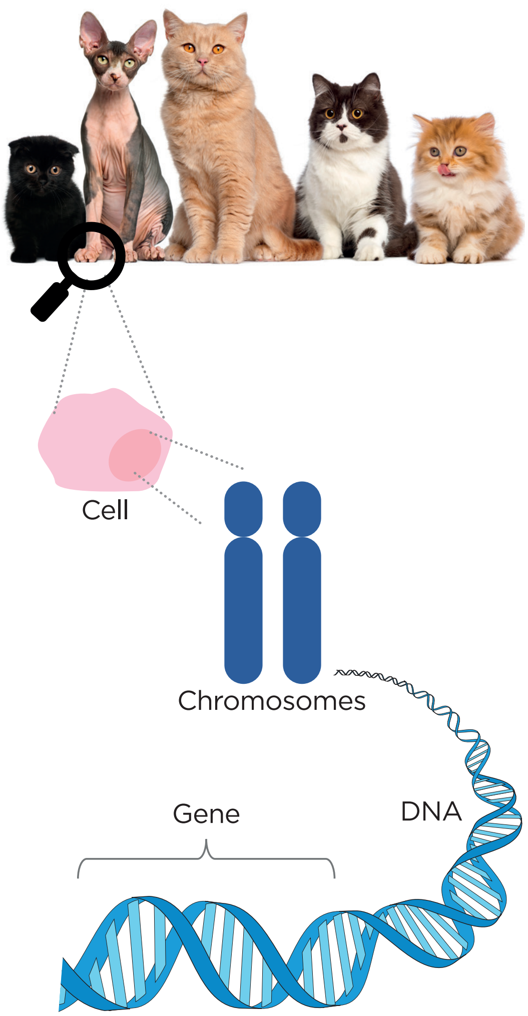
To reduce plastic waste, you may instruct your students not to change pipette tips between samples. Reusing tips will not affect the results of this lab. While best practices generally dictate that pipette tips should always be changed between samples, we also believe it is important to reduce waste when possible, and encourage you to take that into consideration in your instruction.

Student's Guide

Background information

DNA and genes

You know that cats come in many shapes, sizes, and colors. But have you ever wondered why cats can look so different from each other? Much of what determines what a cat will look like is **inherited**, or passed from parents to offspring, through DNA.



1

- **DNA** contains the instructions for the cell.
- DNA is found in structures called **chromosomes.**

2

- A **gene** is a section of DNA that contains a specific instruction for the cell.
- Like humans, cats have two copies of each chromosome, one inherited from each parent.
- Because of this, cats have two copies of each gene, one inherited from each parent.

3

- Cats have 19 pairs of chromosomes (38 total) that carry all their genes.
- The instructions in a cat's genes determine its inherited traits, including some of the cat's appearance.
- Today we will focus on a specific inherited trait related to a cat's fur color.

Background: Stop and think

Q1. Human cells have 23 pairs of chromosomes. How does this compare to cats?

A. Humans have fewer chromosomes because cats have 38 total.

B. Humans have more chromosomes because cats only have 19 pairs of chromosomes.

C. It's impossible to know from the information given.

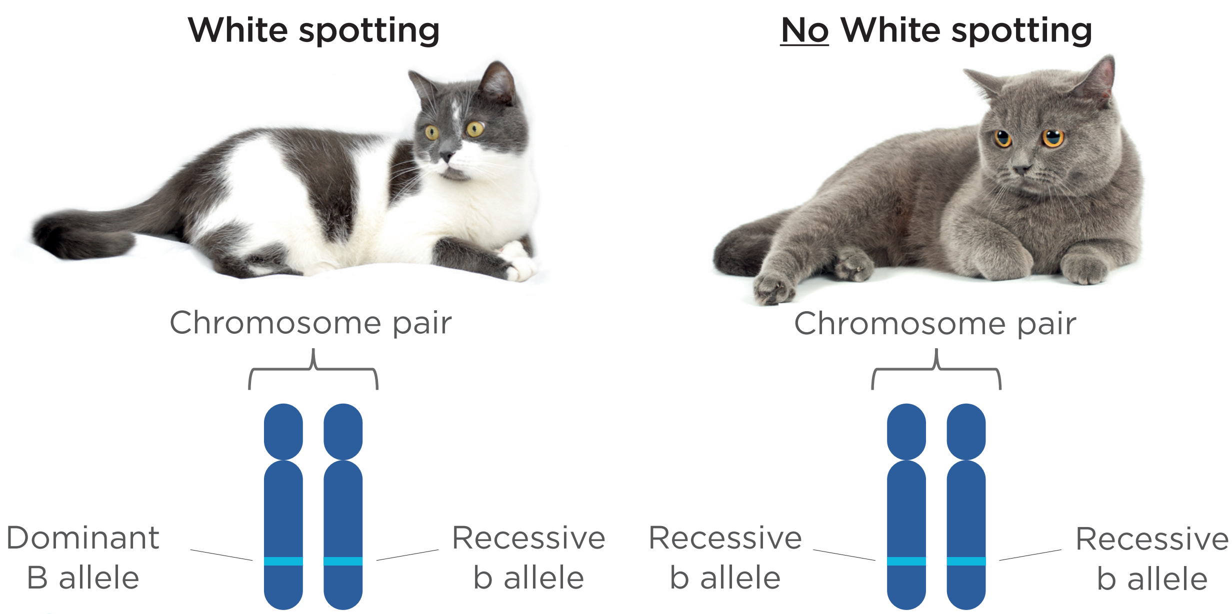
Alleles

1

- Some cats have patches of white fur. This pattern is called **white spotting.**
- White spotting is inherited, so we know that a cat's genes determine if it will have white spotting.

2

- Genes can come in different versions. The different versions have differences in the DNA.
- We call different versions of the same gene **alleles** (pronunciation: "uh-leel").
- Whether or not a cat has white spotting depends on which alleles they inherit from their parents.



3

- People have been breeding cats for a long time. From this, we already know there are two alleles of the gene that controls white spotting in cats.
- The white spotting allele is **dominant.** If a cat has one copy of the dominant allele, the cat will have white spotting, no matter what the other allele is.
- The no-white spotting allele is **recessive.** If a cat does not have any white spotting, it means that both alleles must be the no-white spotting allele.
- We will use a capitalized "B" to represent the dominant allele and a lowercase "b" to represent the recessive allele.

Background: Stop and think

Circle the word(s) that complete each sentence:

Q2. (Alleles/DNA molecules) are different versions of the same (gene/chromosome).

Q3. White spotting in cats is (dominant/recessive). If a cat has Bb alleles, then the cat will (have white spotting/not have white spotting).

Investigating the *KIT* gene in cats

1

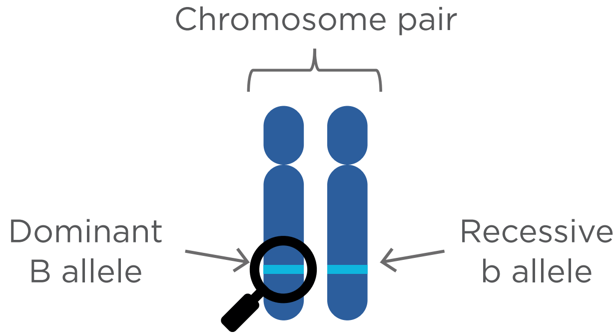
- Scientists know that in animals such as such as horses, white spotting is controlled by a gene called ***KIT*.**
- Cats also have the *KIT* gene and scientists think it might control white spotting too.
- Even though we have known for a long time that white spotting is dominant, it can be difficult to link differences in traits to the actual differences in the DNA of specific genes.

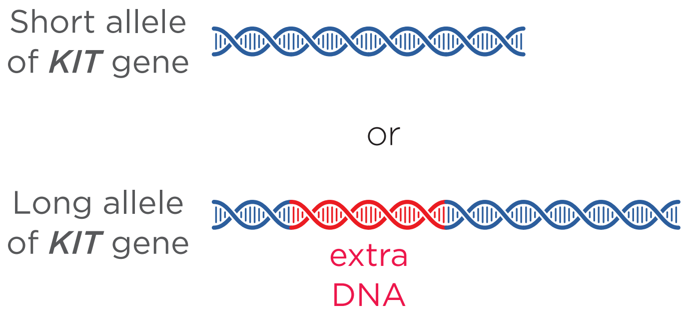
2

- In cats, there are two alleles of the *KIT* gene that scientists suspect control white spotting.
- When comparing the two *KIT* alleles, one allele is longer than the other; in other words, it contains extra DNA. Otherwise the alleles are identical.
- We'll call these two alleles the "long allele" and the "short allele".
- But we don't know which allele (long or short) causes white spotting.

3

Today you will test DNA from cats to determine which allele of the *KIT* gene is the dominant white spotting allele!





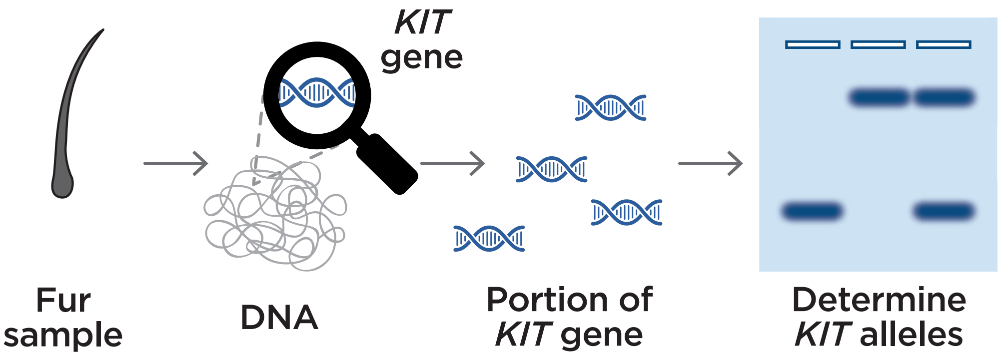
Which allele of the *KIT* gene is the dominant white spotting allele?

Background: Stop and think

Q4. Describe the difference between the two alleles of the *KIT* gene that scientists suspect controls white spotting in cats.

Genetic testing workflow

DNA testing involves multiple steps. To study the cats' *KIT* alleles, their DNA samples will be tested as follows.



Step 1: DNA collection → **Step 2: PCR** → **Step 3: Electrophoresis**

1

- Fur samples are collected from the cats.
- First, DNA was taken out of the fur cells.

2

- Next, a process called **PCR** is used to copy just the *KIT* gene from the cats' DNA samples.

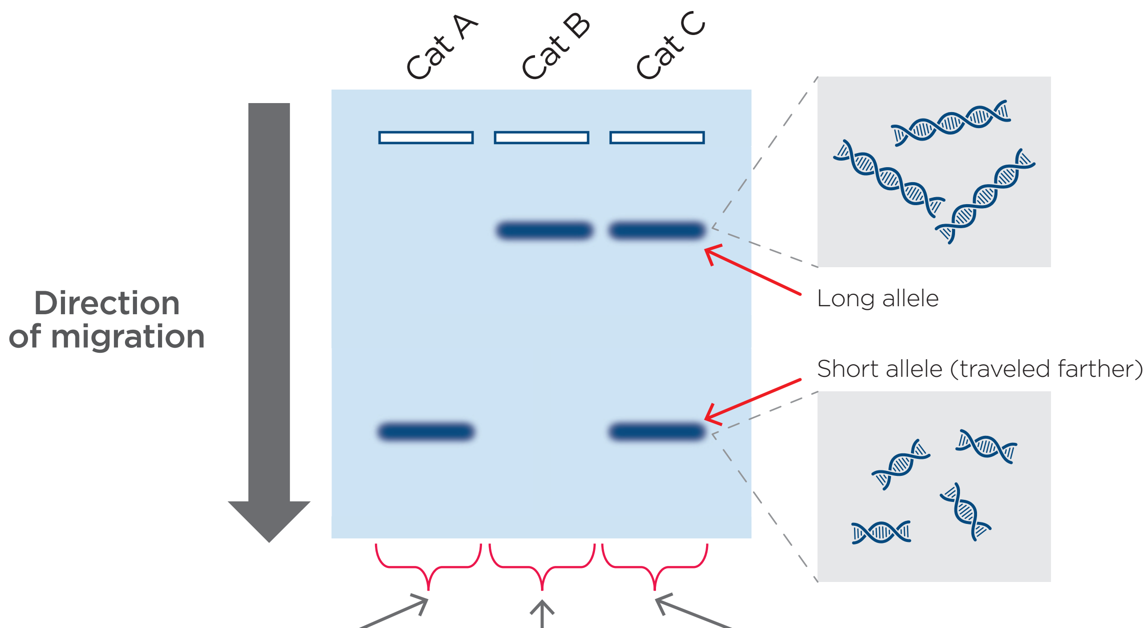
3

- You will perform the last step of the genetic testing to determine which *KIT* alleles each cat has.

Interpreting gel results

1

- You will use gel electrophoresis to study the *KIT* gene in cats.
- **Gel electrophoresis** separates pieces of DNA by size. Smaller pieces of DNA travel farther through the **agarose gel.**
- Because the alleles of the *KIT* gene in cats are different lengths, you can use gel electrophoresis to identify which *KIT* alleles a cat has.
- For a detailed explanation of gel electrophoresis, refer to https://www.minipcr.com/tutorials/



2

- Cat A only has one band. This tells us that all of the DNA was the same size.
- Because the DNA traveled farther, we know for Cat A, both chromosomes have the short *KIT* allele.

3

- Cat B only has one band. This tells us that all of the DNA was the same size.
- Because the DNA traveled less far, we know for Cat B, both chromosomes have the long *KIT* allele.

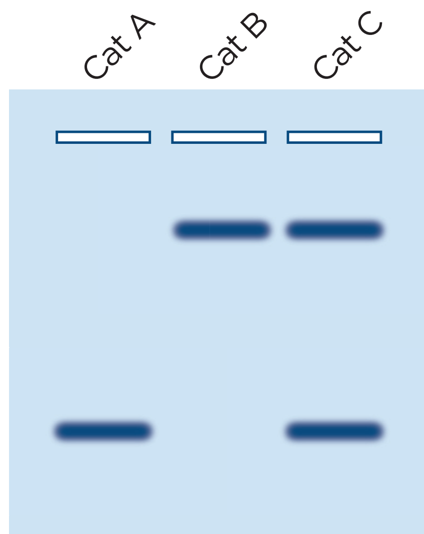
4

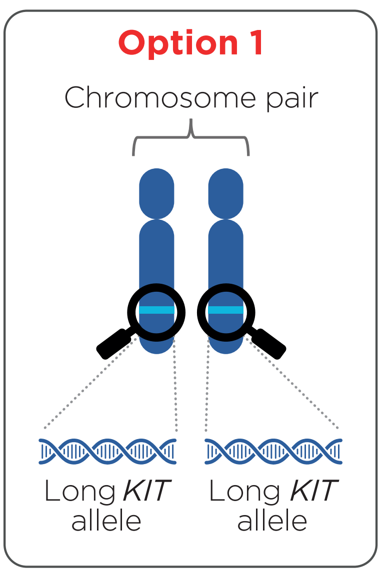
- Cat C has two bands. This tells us that the DNA was two sizes.
- Because Cat C has both bands, we know for Cat C, one chromosome has the short *KIT* allele and the other chromosome has the long *KIT* allele.

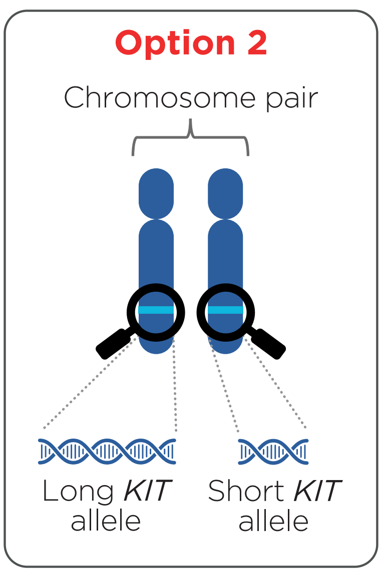
Background: Stop and think

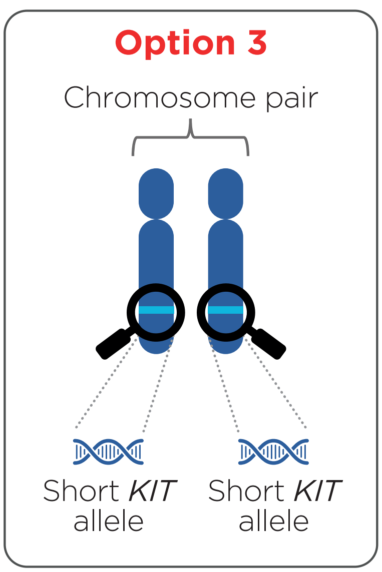
Q5. Why is gel electrophoresis a good tool for studying the different alleles of the *KIT* gene in cats?

Q6. Match the potential allele combinations shown below with the gel results for Cats 1, 2, and 3.









Glossary

Inherited: A trait is inherited when it is passed from parents to offspring through DNA.

DNA: DNA contains the instructions for the cell and is passed down from parent to offspring.

Chromosome: The structures that store DNA in the cell. Organisms like humans and cats have pairs of chromosomes, with one copy of each chromosome inherited from each biological parent.

Gene: A region of DNA that contains a single set of instructions. Different genes correspond to different traits.

White spotting: The presence of patches of white fur on a cat.

Allele: One of two or more alternative versions of the same gene. Different alleles of the same gene have differences in the DNA.

Dominant: Some alleles have a relationship called dominant/recessive. A single copy of a dominant allele of a gene will produce the corresponding dominant trait.

Recessive: Some alleles have a relationship called dominant/recessive. A recessive trait will only be present if both alleles of a gene are recessive.

***KIT* gene:** A gene scientists suspect controls white spotting in cats. The *KIT* gene has been shown to control white spotting in other animals.

Polymerase chain reaction (PCR): A method used to make many copies of a DNA segment you are interested in studying. For more detailed information on electrophoresis, refer to https://www.minipcr.com/polymerase-chain-reaction/.

Gel electrophoresis: A method that separate pieces of DNA by length. For more detailed information on electrophoresis, refer to https://www.minipcr.com/gel-electrophoresis/.

Agarose gel: A type of gel commonly used for gel electrophoresis. Agarose is a sugar from seaweed. At the microscopic level, the inside of an agarose gel looks like a web or a sponge. Small molecules can move through the holes with relative ease, but larger molecules get slowed down. This allows scientists to separate molecules of different sizes.

Today's lab

You work in a lab that studies cat genetics. A fellow scientist has asked for your help with their research on the link between the *KIT* gene and white spotting. You already know that white spotting is dominant, and you will be investigating two alleles of the *KIT* gene: the short allele and the long allele.

Your goal is to determine which *KIT* allele is responsible for white spotting. To do this, you will use gel electrophoresis analyze the *KIT* gene in a family of cats.
For each cat, you will need to:

- **Determine which *KIT* alleles the cat has**
- **Compare those alleles to whether or not the cat has white spotting**

Meet the cats!

Astrid
(mother)

Beau
(father)

Cara **Diego**

Ezra

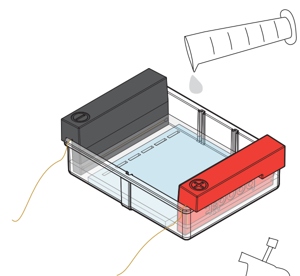
Freya

Student's Guide

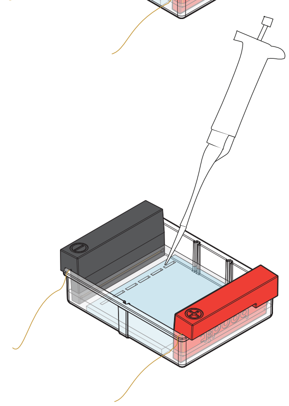
Laboratory guide

Protective gloves and eyewear should be worn for the entirety of this experiment.

See detailed assembly and gel pouring instructions for the Bandit™ STEM Electrophoresis Kit https://www.minipcr.com/bandit-assembly/



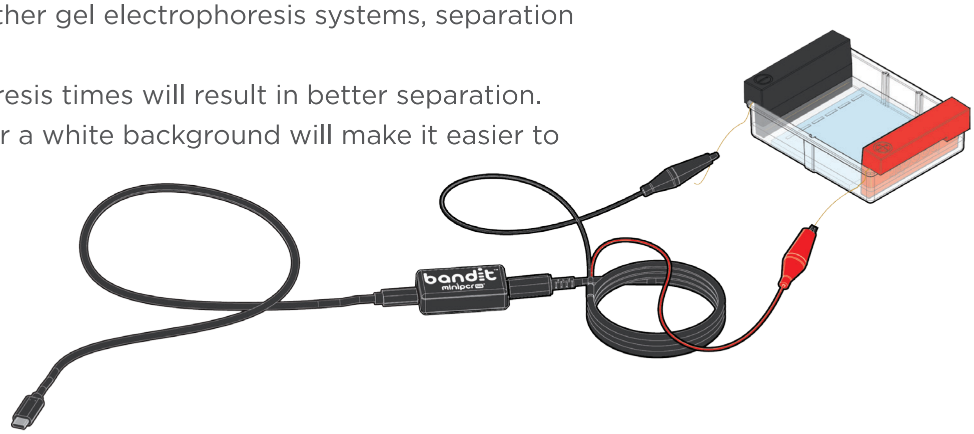
1. **Submerge your gel in enough TBE buffer to just cover the gel and fill the wells**
    - If using a Bandit™ or blueGel™ electrophoresis system you will need approximately 30 ml of TBE buffer.



2. **Use a micropipette to load samples onto the gel from the corresponding tubes in your Load Ready™ Strip**
    - **Lane 1:** 10 µl Astrid DNA
    - **Lane 2:** 10 µl Beau DNA
    - **Lane 3:** 10 µl Cara DNA
    - **Lane 4:** 10 µl Diego DNA
    - **Lane 5:** 10 µl Ezra DNA
    - **Lane 6:** 10 µl Freya DNA

3. **Connect the electrodes and turn on your gel electrophoresis system**

4. **Run the gel for 15-20 minutes or until there is sufficient separation between the bands**
    - Times are based on Bandit™ and blueGel™ electrophoresis systems. If using other gel electrophoresis systems, separation time may vary.
    - Longer electrophoresis times will result in better separation.
    - Placing the gel over a white background will make it easier to see your results.



Pre-lab study questions

Critical thinking

Refer to the picture of the cat family on page 18. By looking at the cats, you already know whether they have white spotting, but what can you deduce about their DNA?

1. Astrid has white spotting. Based only on what she looks like, which combination(s) of alleles could Astrid have for the gene that controls white spotting? Select as many answers as are correct.
   a. BB
   b. Bb
   c. bb

   Explain your reasoning:

2. Beau does not have white spotting. Based only on what he looks like, which combination(s) of alleles could Beau have for the gene that controls white spotting? Select as many answers as are correct.
   a. BB
   b. Bb
   c. bb

   Explain your reasoning:

3. Now let's look at kittens that could be born to Astrid and Beau. You know which alleles Beau has, but Astrid is still uncertain.
Complete both Punnett squares below using each of Astrid's possible allele combinations.

A) Cross: ________ x ________
Astrid's alleles — Beau's alleles

B) Cross: ________ x ________
Astrid's alleles — Beau's alleles

Astrid

Beau

Astrid

Beau

4. If Astrid has BB alleles:

a. What allele combination(s) could kittens born to Astrid and Beau have?

b. Based on their allele combinations, what could these kittens look like in terms of having white spotting or not?

5. If Astrid has Bb alleles:
    a. What allele combination(s) could kittens born to Astrid and Beau have?

    b. Based on their allele combinations, what could these kittens look like in terms of having white spotting or not?

6. Compare your answers in questions 4 and 5 with Astrid and Beau's actual kittens (Cara, Diego, Ezra, and Freya). Based on this information, can you say for sure which allele combination Astrid has? Explain your reasoning.

7. Summarize what you know about the cats in the table below. Use the letters B and b to represent the alleles.

	Cat	**Appearance**	**Alleles**
Parents	Astrid	White spotting	
Parents	Beau	No white spotting	
Kittens	Cara	No white spotting	
Kittens	Diego	No white spotting	
Kittens	Ezra	White spotting	
Kittens	Freya	White spotting	

Post-lab study questions

Interpreting results

1. Use the image of a gel on the right to draw what your gel looks like. For each sample, draw the bands that you see on your actual gel.

2. Label each band as either the short allele or the long allele of the *KIT* gene.

3. Record your results in the table below
   - You should have already completed the first part of this table with the cats' white appearance and alleles in pre-lab question 7 on page 22.
   - The first row has been filled out for you as an example.

Cat	Appearance	Alleles	*KIT* gel results
Astrid	White spotting	Bb	Long allele, short allele
Beau			
Cara			
Diego			
Ezra			
Freya			

Critical thinking

Compare the results in the "Alleles" column and the "*KIT* gel results" column to answer the following questions.

4. When you see a "short allele" in the gel results column, which allele does it seem to match up with?
   A. B allele
   B. b allele

Does this suggest that the short allele is the dominant or recessive allele? Explain your reasoning.

5. When you see a "long allele" in the gel results column, which allele does it seem to match up with?
   A. B allele
   B. b allele

Does this suggest that the long allele is the dominant or recessive allele? Explain your reasoning.

6. Based on your answers to questions 4 and 5, does this support the idea that the *KIT* gene controls white spotting in cats? Explain your reasoning.

Connections to mutations:

7. The ancestors of the domestic cats that live with us as pets were wild cats that lived about 10,000 years ago in what we now call Egypt and the Middle East. The white spotting trait only exists in domestic cats and not in any wild populations. Scientists think a mutation in a domestic cat's DNA led to the white spotting trait. Based on what you learned in this lab, describe how this mutation changed the cat's DNA.

Connections to natural selection:

8. Some changes in the DNA will give an organism an advantage and will spread because of natural selection. Some mutations will put an organism at a disadvantage and will be removed by natural selection. Sometimes domestic cats with white spotting will mate with wild cats and their offspring will grow up to live in the wild. But white spotting is not common in wild cats. Can you think of any reasons having large white spots might put wild cats at a disadvantage? Why may that not be true for domestic cats?

9. Can you think of an environment where white spotting might give wild cats an advantage and become more common in the population?

CER table

Fill in the table based on your results from the lab. Use the rubric on the next page to help your answers.

Question:

Is the long allele or the short allele of the KIT gene responsible for the white spotting trait?

Claim Make a clear statement that answers the above question.	
Evidence Provide data from the lab that supports your claim.	
Reasoning Explain clearly why the data you presented supports your claim. Include the underlying scientific principles that link your evidence to your claim.	

Score	4	3	2	1
CLAIM A statement that answers the original question/problem.	Makes a clear, accurate, and complete claim.	Makes an accurate and complete claim.	Makes an accurate but incomplete or vague claim.	Makes a claim that is inaccurate.
EVIDENCE Data from the experiment that supports the claim. Data must be relevant and sufficient to support the claim.	All of the evidence presented is hightly relevant and clearly sufficient to support the claim.	Provides evidence that is relevant and sufficient to support the claim.	Provides relevant but insufficient evidence to support the claim. May include some non-relevant evidence.	Only provides evidence that does not support claim.
REASONING Explain why your evidence supports your claim. This must include scientific principles/ knowledge that you have about the topic to show why the data counts as evidence.	Provides reasoning that clearly links the evidence to the claim. Relevant scientific principles are well integrated in the reasoning.	Provides reasoning that links the evidence to the claim. Relevant scientific principles are discussed.	Provides reasoning that links the evidence to the claim, but does not include relevant scientific principles or uses them incorrectly.	Provides reasoning does not link the evidence to the claim. Does not include relevant scientific principles or uses them incorrectly.

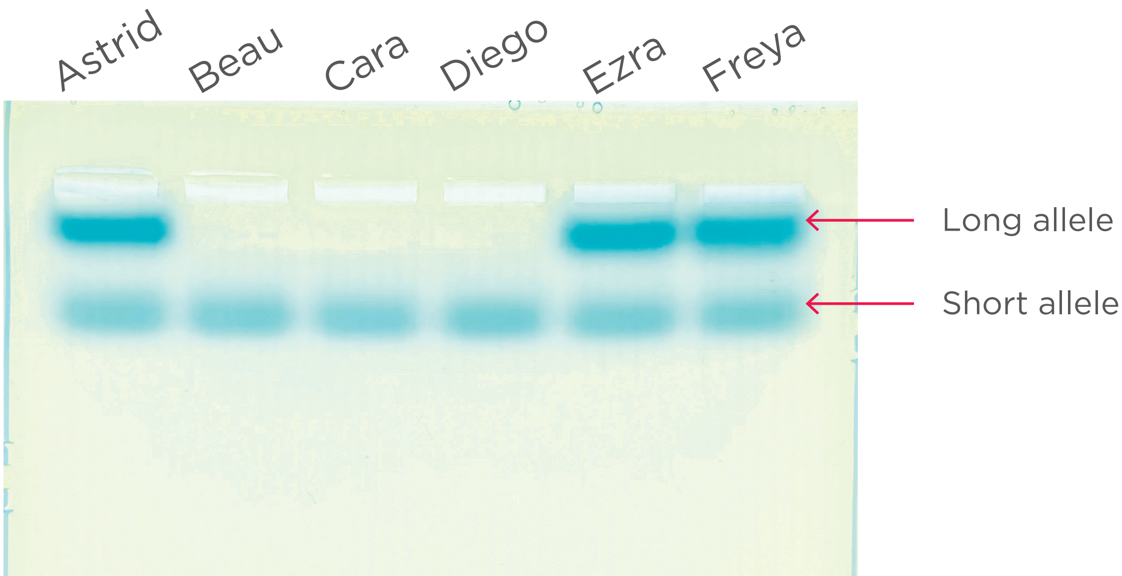
We recommend that teachers use the following scale when assessing this assignment using the rubric. Teachers should feel free to adjust this scale to their expectations.

Rubric Score	3	4	5	6	7	8	9	10	11	12
Equivalent	55	60	65	70	75	80	85	90	95	100

Instructor's Guide

Expected results

Gel electrophoresis results are expected to resemble the image below.



This image represents results obtained after a 20 minute run using the Bandit™ STEM Electrophoresis Kit.

Interpretation:

- Astrid, Ezra, and Freya have one copy of the long *KIT* allele and one copy of the short *KIT* allele
- Beau, Cara, and Diego have two copies of the short *KIT* allele

The long *KIT* allele is dominant and the short *KIT* allele is recessive

Cat	Appearance	Alleles	*KIT* gel results
Astrid	White spotting	Bb	Short allele, long allele
Beau	No white spotting	bb	Short allele, short allele
Cara	No white spotting	bb	Short allele, short allele
Diego	No white spotting	bb	Short allele, short allele
Ezra	White spotting	Bb	Short allele, long allele
Freya	White spotting	Bb	Short allele, long allele

For answers to the lab study questions, email answers@minipcr.com. Please include the name of the lab, as well as your name, school, and title in the body of the email.

Notes on lab design

This lab serves as an introduction to the relationship between genotype and phenotype. We believe our approach provides the right balance between intellectual engagement, inquiry, and accessibility. The design of this lab has simplified certain elements to achieve these goals.

- We omit some common genetics vocabulary, including the terms phenotype, genotype, homozygous, and heterozygous. Teachers are encouraged to use these terms if appropriate for the level of your class.
- We use negatively charged dyes to simulate DNA during gel electrophoresis. This allows for the samples to be directly visualized in the gel without the need for additional staining.
- This lab does not include a detailed explanation of the science behind gel electrophoresis or PCR. However, miniPCR bio™ has published a library of resources that can be used to that effect (refer to https://www.minipcr.com/tutorials/). Bandit™ users can also take advantage of From Circuits to Molecules (https://links.minipcr.com/circuitsTG), an educational activity that walks students through the process of building their Bandit™ system to better understand how gel electrophoresis works.
- In order to make this lab more accessible to introductory classes we omitted discussion of KIT protein function and the specific nature of the genetic differences between the *KIT* alleles. These may be interesting topics of discussion in more advanced classes.
    - The KIT protein is a receptor for a growth factor that is important in the development of multiple cell types, including pigment-producing melanocytes. Mutations in the *KIT* gene have been linked to defects in pigmentation in multiple species.
    - The 7,125 bp insertion is due to the integration of a feline retrovirus in the first intron of the *KIT* gene (David *et al.*, 2014). The intronic insertion interrupts a site that has previously been associated with tissue-specific expression of the KIT protein in melanoblasts, the precursors to pigment-producing melanocyte cells (Cairns *et al*, 2003). Scientists hypothesize that the dominant allele is associated with defects in melanocyte migration or survival (David *et al.*, 2014), both of which can lead to a lack of pigment and a white fur phenotype.
    - Interestingly, there is a third allele of the *KIT* gene that leads to completely white cats. This allele also involves an insertion in the same location as the white spotting allele discussed in this lab. In this case, however, instead of the entire feline retrovirus sequence being present, only a portion of the viral sequence is integrated. This allele is dominant to both the other *KIT* alleles. This allele is also linked to hearing loss. (David *et al.*, 2014)

References

Cairns, L.A., Moroni, E., Levantini, E., Giorgetti, A., Klinger, F.G., Ronzoni, S., Tatangelo, L., Tiveron, C., De Felici, M., Dolci, S., *et al.* (2003). Kit regulatory elements required for expression in developing hematopoietic and germ cell lineages. *Blood* 102, 3954–3962. 10.1182/blood-2003-04-1296.

David, V.A., Menotti-Raymond, M., Wallace, A.C., Roelke, M., Kehler, J., Leighty, R., Eizirik, E., Hannah, S.S., Nelson, G., Schäffer, A.A., *et al.* (2014). Endogenous Retrovirus Insertion in the KIT Oncogene Determines White and White spotting in Domestic Cats. *G3* 4, 1881–1891. 10.1534/g3.114.013425.

Learning goals and skills developed

Student Learning Goals - students will:

- Correlate genotype and phenotype
- Predict genotype and phenotype using Punnett squares
- Solve real-world problems using genetic analysis

Scientific Inquiry Skills - students will:

- Identify or pose a testable question
- Follow detailed experimental protocols
- Create tables or graphs to present their results
- Interpret data presented in a chart or table
- Make a claim based in scientific evidence
- Use reasoning to justify a scientific claim

Molecular Biology Skills:

- Micropipetting
- Principles of PCR
- Preparation of agarose gels
- Agarose gel electrophoresis

Standards alignment

Next Generation Science Standards

Students who demonstrate understanding can:

MS-LS3-1.	Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
MS-LS4-5.	Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.

Science and Engineering Practice	Disciplinary Core Ideas	Crosscutting Concepts
• Analyzing and Interpreting Data • Constructing Explanations and Designing Solutions • Engaging in Argument from Evidence • Obtaining, Evaluating, and Communicating Information	**LS3.A: Inheritance of Traits** **LS3.B: Variation of Traits**	• Patterns • Cause and Effect • Interdependence of Science • Engineering, and Technology • Influence of Engineering, Technology, and Science on Society and the Natural World

Common Core ELA/Literacy Standards

RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
RST.6-8.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.
RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
WHST.6-8.1	Write arguments focused on discipline-specific content.
WHST.6-8.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
WHST.6-8.9	Draw evidence from informational texts to support analysis, reflection, and research.

*For simplicity, this activity has been aligned to middle school NGSS and grades 6-8 Common Core standards.

Ordering information

To order Dye Electrophoresis Lab: Cat Genetics kits, you can:

Call (781)-990-8PCR

email us at orders@minipcr.com

visit www.minipcr.com

Dye Electrophoresis Lab: Cat Genetics (catalog no. KT-1402-01) contains the following reagents:

- Blue dye samples (in Load Ready™ Strips)
- Agarose Tabs™
- TBE buffer

Materials are sufficient for 8 lab groups, or 32 students
Gel reagents can be stored at room temperature
Refrigeration is recommended for blue dye samples to prevent evaporation
Reagents must be used within 12 months of shipment