Inheritance Unit

Grade 1

Contents:

Ambitious Science Teaching Framework

Students investigate a phenomenon where a kitten, “Creamsicle”, with cream fur is born to orange fur parents. Readings and activities support students in making sense about patterns in inheritance. Throughout the unit, students have multiple opportunities to create and revise their scientific models about Creamsicle' fur color in light of evidence they collect from activities. Ultimately, the model and explanation students create is to explain how and why Creamsicle could be born with cream fur; however, knowing the big science ideas behind the system allows students to explain multiple related events, including events in their own families.

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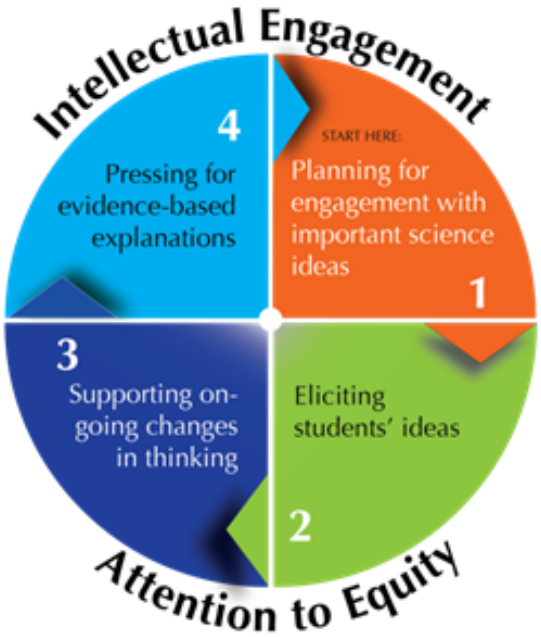
Ambitious Science Teaching

We provide here a vision of ambitious teaching - teaching that is effective, rigorous, and equitable. But more than that, we provide a framework or research-based teaching practices that are consistent with this vision and a wide range of tools that can transform how students learn in your classroom. The vision, practice, and tools will furnish a common language about teaching for a group of science educators committed to improvement of teaching. You will be able to identify "what we will get better at" and how to get started.



Ambitious teaching aims to support students of all racial, ethnic, and social class backgrounds in deeply understanding science ideas, participating in the talk of the discipline, and solving authentic problems. This teaching comes to life through four sets of teaching practices that are used together during units of instruction. These practices are powerful for several reasons. They have consistently been shown through research to support student engagement and learning. They can each be used regularly with any kind of science topic. And finally, because there are only four sets of practices, we can develop tools that help both teachers and students participate in them, anyone familiar with the practices can provide feedback to other educators working with the same basic repertoire, teachers can create productive variations of the practices, and everyone in the science education community can share a common language about the continual improvement of teaching.

The four Ambitious and Equitable Science Teaching Practices are summarized in the table below.

Practices	**What does it LOOK like?**
Planning for engagement with important science ideas.	• Planning a unit that connects a topic to a phenomena that it explains (Chemical Reactions - Bike Rusting, Photosynthesis - Seed Becoming a Tree) • Teaching a topic within real-world context
Eliciting students' ideas	• Asking students to explain HOW and WHY they think a phenomena happens (How did the bike change? Why did it change? What is happening at the unobservable level?
Supporting on-going changes in thinking	• Using ALL activities/lesson to explain the phenomena. • Giving students opportunities to revise their thinking based on what they're learning.
Pressing for evidence-based explanations	• Allowing students to create a final model or explanation about the phenomena. • Pressing students to connect evidence to their explanation

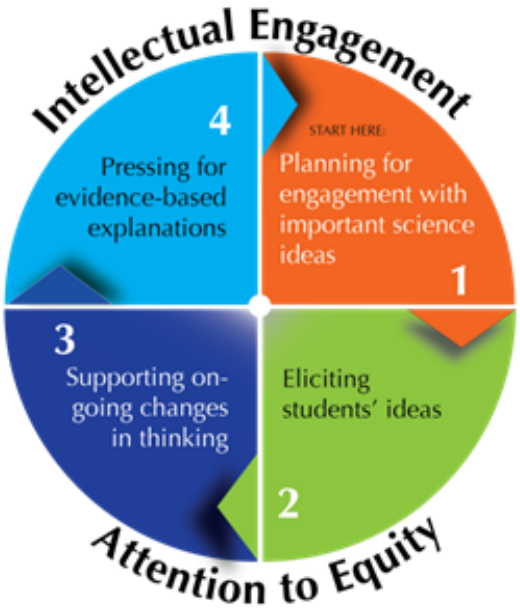
Many teachers want to know what their classrooms should look like and sound like - they want to understand how to interact with their students about science ideas and students' ideas. This is especially true now the *Next Generation Science Standards* are being used in many states. As a result of the last 30 years of classroom research, we know enough about effective instruction to describe in clear terms what kinds of teaching practices have been associated with student engagement and learning. This research tells us that there are many ways that teachers can design and implement effective instruction, but that there are common underlying characteristics to all these examples of teaching that can be analyzed, described, and learned by professionals. These practices embody a new form of "adaptive expertise" that EVERY science educator can work towards. Expert teaching can become the norm, not reserved for a select few. Ambitious teaching is framed in terms of practices that any teacher can learn and get better at over time. What would we see if we entered a classroom of a science educator using ambitious teaching? To give you a sense of what ambitious teaching looks like, we have described below some features common to all science classrooms where ambitious teaching is being implemented (listed on right). These features address everyday problems with learning and engagement that teachers face (listed on left.

Common problems in supporting student engagement and learning	**What you'd see in a science classroom where ambitious teaching is the aim**
The problem: *Students don't see how science ideas fit together.* Each day is perceived by students to be the exploration of ideas that are unconnected with previous concepts and experiences.	At the beginning of the unit, students are focused on developing an evidence-based explanation for a complex event, or process. Students know that throughout the unit, most of the activities, readings, and conversations will contribute to this explanation.
The problem: *An oversimplified view of what it means "to know."* Science ideas perceived to be straightforward and learnable within a lesson - either you get it or you don't.	An idea is never taught once and for all, but revisited multiple times. Students' science explanations are treated as partial understandings that have to be revisited over time to become more refined and coherent.
The problem: *Lack of student engagement.* Students' experiences and interests not elicited or seen as relevant. Student ideas treated as "correct" or "incorrect."	Students' ideas and everyday experiences are elicited and treated as resources for reasoning, students' partial understandings are honored as a place to start. They are made public and built upon.
The problem: *Students reluctant to participate in science conversations.* Teachers dominate the talk, ask primarily for right answers, get brief responses from students.	Teachers use a varied repertoire of discourse moves to facilitate student talk. Gues and scaffolds for talk help students feel comfortable interacting with peers.
The problem: *Some students have little support for accomplishing tasks that would otherwise be within their grasp.* Little or no guidance for students' intellectual work. Giving "clear directions" is seen as enough to ensure participation in activities.	There is scaffolding that allows students to participate in science-specific forms of talk, in group work, and in science practices.
The problem: *Invisibility of student ideas and reasoning.* Teacher does not know what students think - their heads are a cream box. Cannot then work on students' ideas. Students cannot take advantage of the ideas or ways of reasoning by their peers.	Students' thinking made visible through various public representations (tentative science models, lists of hypotheses, questions they have, etc.). The teacher can see how students think and how that thinking could change over time. Students benefit from seeing and hearing the reasoning of others.
The problem: *Illusion of rigor.* Students reproduce textbook explanations, lean on vocabulary as a substitute for understanding. Talk of evidence and claims are rare.	The teacher presses for complete, gapless explanations for unique real-life events or processes, and press for the use of evidence to support claims.

As you will see, ambitious teaching is not a "method," and the teaching practices are not scripts. It is a set of principled practices that must be adapted to your classroom needs. Coaches and other teachers can work with you to do this ambitious work.

Curriculum Guide
Lesson & Activity Guides

Ambitious Science Teaching Framework



This curriculum guides follows the four core teaching practices of the Ambitious Science Teaching Framework. This model-based inquiry approach to science teaching leverages students' existing personal experiences and current understanding about causal mechanisms in their world to revise their own explanations of specific, contextualized scientific phenomena.

Planning for Engagement with Important Ideas

In the Framework for Ambitious Science Teaching, the first phase in any unit of instruction is planning. Only when teachers understand where they are doing in the unit can they begin to design instruction. One goal in this planning practice is to support teachers in moving from topics toward relationships between science ideas which can explain multiple real-world phenomena.

This section provides teachers with some general science background around the content goals for this unit as well as an explanation for a specific phenomenon for this unit - Creamsicle, the kitten with cream fur born to two orange-furred cats. It also suggests ways teachers can identify related phenomenon that may be more relevant to their specific students and can be explained by the same science ideas.

Unit Goals

This life science unit focuses on how traits are passed from parent to offspring, how these traits help the organisms survive, and how humans have mimicked these traits for our benefit. Students will combine some or all of the following ideas to explain one or more real-world phenomena.

- Traits are controlled by genes which are passed from parents to offspring over multiple generations.
- Both parents contribute genes equally and randomly to their offspring which results in similar but not identical offspring.
- Not all traits are expressed but they can still passed down and reappear in future offspring further resulting in variation between parents and offspring.
- Behaviors that help ensure an organism's survival are controlled by both genes and the environment and traits that are beneficial in an environment are persistent over time across generations.

Put another way:

If students understand...		Then, students can explain...
...that traits are controlled by genes which are passed from parent to offspring over multiple generations...	→	...how fur color can be passed in a family of cats.
...how each parents contributes half of their genetic information randomly to each offspring...	→	...how variation exists between parent and offspring.
...how traits can be present in an individual but not expressed...	→	...why particular traits, such as fur color, can skip generations.
...the role genes and the environment play in behavior	→	...why beneficial traits persist in populations over time.

Next Generation Science Standards

1st Grade Inheritance Unit

The performance expectations and related dimensions below are from the Next Generation science standards. For more detailed descriptions of the standards visit http://nextgenscience.org

1-LS1 From Molecules to Organisms: Structures and Processes

1-LS1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.* [Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]

1-LS1-2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive. [Clarification Statement: Examples of patterns of behaviors could include the signals that offspring make (such as crying, cheeping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.

- Use materials to design a device that solves a specific problem or a solution to a specific problem. (1-LS1-1)

Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information.

- Read grade-appropriate texts and use media to obtain scientific information to determine patterns in the natural world. (1-LS1-2)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Scientists look for patterns and order when making observations about the world. (1-LS1-2)

Disciplinary Core Ideas

LS1.A: Structure and Function

- All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1)

LS1.B: Growth and Development of Organisms

- Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. (1-LS1-2)

LS1.D: Information Processing

- Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. (1-LS1-1)

Crosscutting Concepts

Patterns

- Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (1-LS1-2)

Structure and Function

- The shape and stability of structures of natural and designed objects are related to their function(s). (1-LS1-1)

Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World

- Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world. (1-LS1-1)

Connections to other DCIs in first grade: N/A

Articulation of DCIs across grade-levels: **K.ETS1.A** (1-LS1-1); **3.LS2.D** (1-LS1-2); **4.LS1.A** (1-LS1-1); **4.LS1.D** (1-LS1-1); **4.ETS1.A** (1-LS1-1)

Common Core State Standards Connections:

ELA/Literacy –

RI.1.1 Ask and answer questions about key details in a text. (1-LS1-2)
RI.1.2 Identify the main topic and retell key details of a text. (1-LS1-2)
RI.1.10 With prompting and support, read informational texts appropriately complex for grade. (1-LS1-2)
W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-LS1-1)

Mathematics –

1.NBT.B.3 Compare two two-digit numbers based on the meanings of the tens and one digits, recording the results of comparisons with the symbols >, =, and <. *(1-LS1-2)*
1.NBT.C.4 Add within 100, including adding a two-digit number and a one-digit number, and adding a two-digit number and a multiple of 10, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning uses. Understand that in adding two-digit numbers, one adds tens and tens, ones and ones; and sometimes it is necessary to compose a ten. *(1-LS1-2)*
1.NBT.C.5 Given a two-digit number, mentally find 10 more or 10 less than the number, without having to count; explain the reasoning used. *(1-LS1-2)*
1.NBT.C.6 Subtract multiples of 10 in the range 10-90 from multiples of 10 in the range 10-90 (positive or zero differences), using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used. *(1-LS1-2)*

1-LS3 Heredity: Inheritance and Variation of Traits

1-LS3 Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can:

1-LS3-1. Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents. [Clarification Statement: Examples of patterns could include features plants or animals share. Examples of observations could include leaves from the same kind of plant are the same shape but can differ in size; and, a particular breed of dog looks like its parents but is not exactly the same.] [Assessment Boundary: Assessment does not include inheritance or animals that undergo metamorphosis or hybrids.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.

- Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-LS3-1)

Disciplinary Core Ideas

LS3.A: Inheritance of Traits

- Young animals are very much, but not exactly like, their parents. Plants also are very much, but not exactly, like their parents. (1-LS3-1)

LS3.B: Variation of Traits

- Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (1-LS3-1)

Crosscutting Concepts

Patterns

- Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (1-LS3-1)

Connections to other DCIs in first grade: N/A

Articulation of DCIs across grade-levels: **3.LS3.A** (1-LS3-1); **3.LS3.B** (1-LS3-1)

Common Core State Standards Connections:

ELA/Literacy –

RI.1.1 Ask and answer questions about key details in a text. (1-LS3-1)

W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-LS3-1)

W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-LS3-1)

Mathematics –

MP.2 Reason abstractly and quantitatively. *(1-LS3-1)*

MP.5 Use appropriate tools strategically. *(1-LS3-1)*

1.MD.A.1 Order three objects by length; compare the lengths of two objects indirectly by using a third object. *(1-LS3-1)*

Next Generation Science Standards

Disciplinary Core Idea Progressions K-12 for DCIs featured in this unit

The performance progression for DCI's K-12 are from the Next Generation science standards. For more detailed descriptions of learning progressions and/or Disciplinary Core Ideas, visit http://nextgenscience.org.

DCI	K-2	3-5	6-8	9-12
LS1.A Structure and Function	All organisms have external parts they use to perform daily functions.	Organisms have both internal and external macroscopic structures that allow for growth, survival, behavior, and reproduction.	All living things are made up of cells. In organisms, cells work together to form tissues and organs that are specialized for particular body functions.	Systems of specialized cells within organisms help perform essential functions of life. Any one system in an organism is made up of numerous parts. Feedback mechanisms maintain an organism's internal conditions within certain limits and mediate behaviors.
LSI.B Growth and Development of Organisms	Parents and offspring often engage in behaviors that help the offspring survive.	Reproduction is essential to every kind of organism. Organisms and unique and diverse life cycles.	Animals engage in behaviors that increase the odds of reproduction. An organism's growth is affected by both genetic and environmental factors.	Growth and division of cells in organisms occurs by mitosis and differentiation for specific cell types.
LS1.D Information Processing	Animals sense and communicate information and respond to inputs with behaviors that help them grow and survive.	Different sense receptors are specialized for particular kinds of information. Animals use their perceptions and memories to guide their actions.	Each sense receptor responds to different inputs, transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behavior or memories.	N/A
LS3.A Inheritance of Traits	Young organisms are very much, but not exactly, like their parents and also resemble other organisms of the same kind.	Different organisms vary in how they look and function because they have different inherited information; the environment also affects the traits that an organism develops.	Genes chiefly regulate a specific protein, which affects an individual's traits.	DNA carries information for forming species' characteristics. Each cell in an organism has the same genetic content, but genes expressed by cells can differ.
LS3.B Variation of Traits			In sexual reproduction, each parent contributes half of the genes acquired by the offspring resulting in variation between parent and offspring. Genetic information can be altered because of mutations, which may result in beneficial, negative, or no change to proteins in or traits of an organism.	The variation and distribution of traits in a population depend on genetic and environmental factors. Genetic variation can result from mutations caused by environmental factors or errors in DNA replication, or from chromosomes swapping sections during meiosis.

Teacher Background Knowledge

This section provides science content knowledge and explanations to explain the general phenomenon of how traits are passed from parents to offspring and explains a specific phenomenon: how Creamsicle got cream fur when both his parents had orange fur. The last part of the section provides information from *A Framework for K-12 Science Education* describing knowledge corresponding to each Disciplinary Core Idea featured in this unit.

1. Puzzling Phenomenon - How did Creamsicle get cream fur when his parents both have orange fur?

The scientific explanation of this phenomenon requires an understanding of the key concepts of this unit identified from the Next Generation Science Standards. Though this phenomenon is contextualized and relates to a specific cat family, the story may or may not seem as relevant to students as something from their own experience or that of a peer. Other phenomena can be substituted as a focal phenomenon for the unit as long as they can be explained with the ideas targeted in the NGSS. If a different phenomenon is selected, be sure to do research and write out a scientific explanation for the phenomenon.

NOTE: In terms of responsive teaching, it is important for teachers to know student's families, and to be prepared to help students engage in dialogue about multiracial and LGBTQ families. Please consider complementing this curriculum with anti-bias curriculum. Here are some resources:

- https://raceinstitute.org/anti-racism-resources-for-teachers-2/
- https://www.adl.org/education/resources/tools-and-strategies/creating-an-anti-bias-learning-environment#.V5oyWzkrK2w
- https://www.tolerance.org/
- http://www.understandingrace.org/home.html
- https://www.glsen.org/article/lgbt-issues-elementary-schools
- http://www.transstudent.org/

A. What happened?

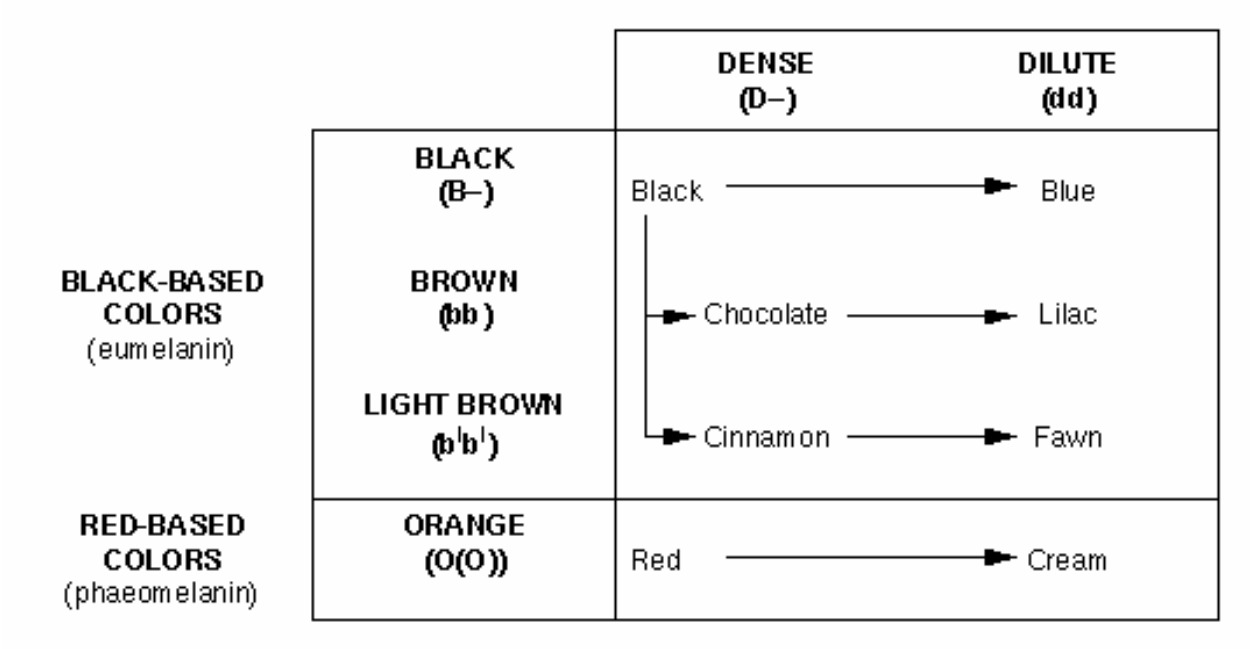
"Creamsicle" is a kitten with cream fur that was born to two parent cats with orange fur. Each of his 3 other siblings in the liter had orange fur. When looking back at Creamsicle' family tree, it is known that Creamsicle's maternal grandmother had cream fur.

B. Why did this happen?

Cat fur color is determined by several different genes. These genes are passed from parent to offspring when a kitten receives one fur color gene from mom and another fur color gene from dad. There are several different combinations of genes that are possible but for the case of Creamsicle' family, we need to understand the genes responsible for producing both cream and orange fur. In short, cat fur color is determined by both the gene for color (orange - called “red”, **O**) and the gene for color density (**D**). Because the O gene is sex-linked (found on the x chromosome), and dominant over other colors, we can focus instead on the gene for fur color density. We can assume that Creamsicle’s parents are heterozygous for dense fur coloration (**Dd**) and his siblings are either heterozygous (**Dd**) or homozygous dominant (**DD**). Creamsicle got his cream colored fur when he received 2 recessive copies (**dd**) for fur color density. Therefore, his genotype is **ddO**.

In further detail, there are two chemically different kinds of melanin: eumelanin and phaeomelanin. Eumelanin granules are thought to be spherical in shape and absorb almost all light, giving black pigmentation. Phaeomelanin granules are thought to be elongated "footballs" in shape, and reflect light in the red-orange-yellow range.

Several genes can cause variation in the density of the the melanin granules, so other colors can be produced. The most variation is found in the black-based (eumelanistic) colors. The following table lists the commonly accepted names for the basic colors, by genotype:



The red-based (phaeomelanistic) colors have little variation. Red is usually described as orange or "marmalade", but some red cats have rather pale pigmentation and so people may describe them as yellow. Cream is the dilute form of Red, and is described as a buff color. The symbol for the gene for Red/Cream is (O).

	AGOUTI (A–)			NON-AGOUTI (aa)		
	Ticked (T^a–)	**Mackerel (T–)**	**Classic (t^bt^b)**	**Ticked (T^a–)**	**Mackerel (T–)**	**Classic (t^bt^b)**
Black (B–D–)	Brown Ticked Tabby	Brown Mackerel Tabby	Brown Classic Tabby	Black Solid	Black Solid	Black Solid
Blue (B–dd)	Blue Ticked Tabby	Blue Mackerel Tabby	Blue Classic Tabby	Blue Solid	Blue Solid	Blue Solid
Chocolate (b^cb^cD–)	Chocolate Ticked Tabby	Chocolate Mackerel Tabby	Chocolate Classic Tabby	Chocolate Solid	Chocolate Solid	Chocolate Solid
Lilac (b^cb^cdd)	Lilac Ticked Tabby	Lilac Mackerel Tabby	Lilac Classic Tabby	Lilac Solid	Lilac Solid	Lilac Solid
Cinnamon (b^lb^lD–)	Cinnamon Ticked Tabby	Cinnamon Mackerel Tabby	Cinnamon Classic Tabby	Cinnamon Solid	Cinnamon Solid	Cinnamon Solid
Fawn (b^lb^ldd)	Fawn Ticked Tabby	Fawn Mackerel Tabby	Fawn Classic Tabby	Fawn Solid	Fawn Solid	Fawn Solid
Red (D–O(O))	Red Ticked Tabby	Red Mackerel Tabby	Red Classic Tabby	Same as agouti (A–) (Non-agouti is inoperative on orange pigment)		
Cream (ddO(O))	Cream Ticked Tabby	Cream Mackerel Tabby	Cream Classic Tabby			

C. Finding alternative phenomena

A local phenomenon could anchor the unit instead of the Creamsicle family. Or students could simultaneously explain a local phenomenon alongside the Creamsicle phenomenon, identifying similarities in underlying causal mechanisms but different in context.

One possible alternative phenomenon is outlined below. Know that this phenomenon will most likely open up dialogue about multiracial families, and teachers will want to support this curriculum with anti-bias curriculum that helps students talk responsibly about race, stereotypes, and biases.

The **B gene** controls the production of eumelanin, the pigment that makes a cat's fur black. It comes in three alleles, or types. The **B** allele, which produces black fur, is dominant, meaning a cat only needs to get a B allele from one parent in order to be black. Two other recessive alleles of the B gene, **b** and **b'**, produce chocolate and cinnamon coat colors, respectively. The one exception to the dominant B gene resulting in a cat with black fur is the presence of the "Dominant White" gene. The **W gene** is known as a masking gene because if the dominant **W** allele is present, the cat will be white, no matter what the other coat color and pattern alleles say, including the B allele.

In Midnight's family, both the B gene and W gene are present. Specifically, Midnight's parents must both be heterozygous (WB). They have white fur but they also carry the unexpressed dominant gene for black fur. When Midnight's parents bred, most of the kittens were solid white. In fact, each kitten had a 75% chance of being born with white fur. This is because white fur kittens can result from either homozygous dominant (WW) or heterozygous (WB) genotypes. Because Midnight has black fur, we know that his genotype must be BB (or Bb). See the punnett square below to see the possible outcomes of offspring born to Midnight's parents.

	W	B
W	WW	WB
B	WB	BB

D. Sources

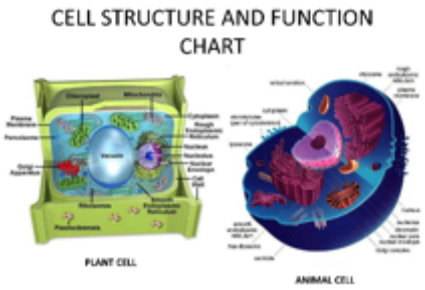
- Genes and cat fur color: http://www.catster.com/lifestyle/cat-genes-science-fur-color
- Genetics of fur: http://www.fanciers.com/other-faqs/color-genetics.html

2. General Science Background – Organization of Life

A. Cells - the Basic Unit of Life

All living things share certain characteristics such as the need for water, making waste, exchanging gases, requiring energy, reproducing, and being made of cells. A cell is the building block of life because it is the smallest unit of life that can carry out of all the characteristics of life. All living things are made of one or more cells. Single celled organisms include bacteria and protists. These organisms carry out the functions of life but are limited by being one cell. Specifically, they have limited complexity and smaller size.

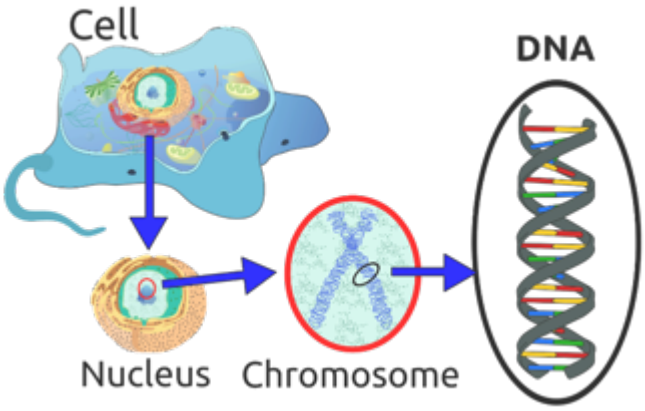
Multicellular Organisms. Multicellular organisms are capable of cell differentiation (having different types of cells with different functions), and thus increased complexity and efficiency, as well as a larger size. In multicellular organisms, cells with similar structure and function are organized to form tissues. These cells work together to carry out the required job of the tissues. Some examples of tissues include cardiac muscle tissue whose function is to pump blood through the heart, epithelial tissue (tissue found in skin) whose function is to protect an animal from the outside world, or root hair tissue in plants whose function is to take up water and minerals from the soil. Different groups of tissues that work together to carry out specialized jobs are organized into organs. Some examples of organs in animals include the heart, lungs, liver, and intestines. Some examples of organs in plants include leaves and roots. Different groups of organs that work together to perform specialized jobs are organized into organ systems. Some examples include the respiratory system, circulatory system, and reproductive system in animals and the leaf canopy system in plants.



Cell Parts and Their Functions. Within each cell there are specialized structures that allow the cell to carry out the functions of life. Plant and animal cells both have cell membranes (to control what goes in and out of the cell), cytoplasm (a jelly-like substance that hold cell parts in place and support chemical reactions), and nucleus (stores the genetic information that controls what happens inside the cell). Cell structures unique to plants include the cell wall (to provide structure and support to the plant) and chloroplasts (the site where photosynthesis occurs).

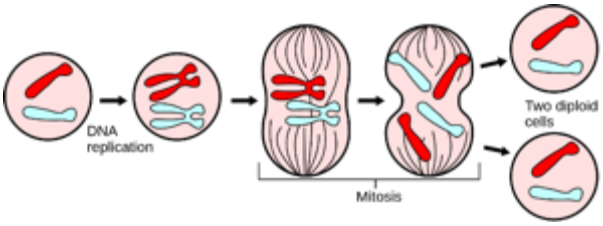
B. DNA – The Instructions of Life

Information for this section from:
http://kidshealth.org/en/parents/about-genetics.html

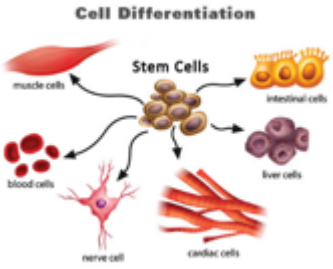


Inside every cell nucleus is our **DNA (deoxyribonucleic acid)**. DNA can be thought of as the chemical blueprints affecting how our body looks and functions. DNA is a long molecule that is tightly coiled up into **chromosomes**. Humans have 46 chromosomes (arranged in 23 pairs) and cats have 38 chromosomes (arranged in 14 pairs). The sections of a DNA strand that contain instructions for making specific body proteins are called **genes**. Each gene can be thought of as a recipe you'd find in a cookbook. Some recipes tell the body how to produce physical features such as fur color or tail length, while others tell the body how to make chemicals that control how the body functions. Scientists believe that human DNA contains approximately 25,000 protein-coding genes while domestic cats have about 20,000. An individual's genes are a combination of the genes they inherited from both parents at conception. An organism's genome is its entire genetic information. Every organism's genome is unique, except for identical twins.

- DNA - The Book of You: https://www.youtube.com/watch?v=aeAL6xThfL8



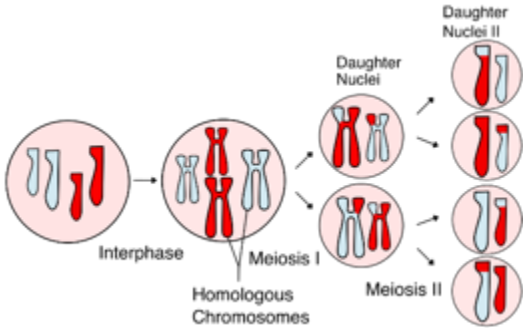
Mitosis. In multicellular organisms, individual cells reproduce in a process called mitosis in order for the organism to grow, develop, and repair. During this type of cell reproduction, each cell duplicates its DNA and makes two identical daughter cells. These cells are then structurally and functionally the same as the parent cell.



Mitosis and Cell Differentiation. As a multicellular organism develops from a single fertilized egg, the cells reproduce using the process of mitosis. As the cells reproduce, they are exposed to small differences in their immediate environment which activate or inactivate different genes. This then results in small changes in the structure and function of the cells, known as cell differentiation, and allows the organism to have specialized cells that carry out unique jobs, even though each cell has identical genetic information. For example, heart muscle cells are structurally and functionally different from skin cells in an individual organism even though they have the same DNA.

- Cellular Specialization: https://www.youtube.com/watch?v=YtvL-LQlPrU

Meiosis. When two multicellular organisms reproduce and produce offspring, the process of cell division is known as meiosis. During this process, one parent cell divides into four cells with half of the original DNA. In males, these cells are known as sperm, and in females, these cells are known as eggs. As the 4 sex cells are created, the chromosomes from the parent cell splits in half randomly. Since the DNA from the egg cells of the kittens' mother and the DNA from the sperm cells of the kitten's father combine together randomly to make the kittens, each kitten has a different, but similar, genome to their parents. Additionally, a process known as crossing over can further result in differences between parents and offspring. Crossing over occurs when homologous chromosomes line up in preparation for replication. Small sections of DNA can be moved between homologous chromosomes and result in unique gene combinations.



Hidden versus Expressed Traits. Alleles are different forms of the same gene. For example, a kitten may have the allele for blue eyes or the allele for brown eyes. An allele can be dominant or recessive. For every trait, each kitten has two alleles, one from each parent. For the recessive trait to be displayed (the kitten has the recessive phenotype), the kitten must have two recessive alleles (homozygous recessive genotype). For the dominate trait to be displayed, (the kitten has a dominant phenotype), the kitten must have either one dominant and one recessive allele (heterozygous genotype) or two dominant alleles (homozygous dominant genotype). In the kittens, the gene that codes for orange fur is a masking gene; it will hide other existing genes such as that for cream fur. Thus, in order for the kitten to have cream fur, both alleles must code for cream fur. Most traits are actually a result of a combination of alleles, not just one. The kittens' height, for example, is a result of multifactorial inheritance (multiple genes interacting). Environmental factors and incomplete or co-dominance of genes can also affect how traits are expressed.

- DNA- The Book of You: https://www.youtube.com/watch?v=aeAL6xThfL8

C. Animal Growth & Survival

Animals, including kittens and cats, have body parts and behaviors, controlled by their genes, that capture and convey different kinds of information needed for growth and survival. In order to respond to changes in the environment, cat ears are capable of rotating toward the direction of sound to improve hearing. Cats have large round pupils that dilate in darkness to maximize the amount of light at night and thus improve their nocturnal hunting. When threatened, cats arch their back to appear larger and more threatening in order to protect themselves and ensure their survival. The body parts of a cat are also designed to hunt and retrieve food. The strong hind legs on a cat allow strength and speed in order to catch food and avoid predation, and the sharp teeth are designed to consume their prey. The sickle-shaped sharp claws allow cats to grip their prey and hold on to it, as well as dig and defend themselves. Cats also have internal and external receptors that convey information. Whiskers serve as an external sensor that allow cats to determine ambient temperature and the dimensions and qualities of objects near them. The wet nose of a cat serves to better pick up scents and the behavior of rubbing their cheeks on objects is a way of marking their territory. Additionally, their eyes reflect light at night (due to a thin membrane at the back of the eye called the tapetum lucidum) to improve nocturnal vision and convey messages to the brain that perceive the objects.

3. Additional General Life Science Background

General life science background for teachers corresponding to the Disciplinary Core Ideas taken directly from National Academies Press *A Framework for K-12 Science Education* available in its entirety for free: http://www.nap.edu/download.php?record_id=13165

LS1.A: STRUCTURE AND FUNCTION
Source: National Academies Press
How do the structures of organisms enable life's functions?

A central feature of life is that organisms grow, reproduce, and die. They have characteristic structures (anatomy and morphology), functions (molecular-scale processes to organism-level physiology), and behaviors (neurobiology and, for some animal species, psychology). Organisms and their parts are made of cells, which are the structural units of life and which themselves have molecular substructures that support their functioning. Organisms range in composition from a single cell (unicellular microorganisms) to multicellular organisms, in which different groups of large numbers of cells work together to form systems of tissues and organs (e.g., circulatory, respiratory, nervous, musculoskeletal), that are specialized for particular functions. Special structures within cells are also responsible for specific cellular functions. The essential functions of a cell involve chemical reactions between many types of molecules, including water, proteins, carbohydrates, lipids, and nucleic acids. All cells contain genetic information, in the form of DNA. Genes are specific regions within the extremely large DNA molecules that form the chromosomes. Genes contain the instructions that code for the formation of molecules called proteins, which carry out most of the work of cells to perform the essential functions of life. That is, proteins provide structural components, serve as signaling devices, regulate cell activities, and determine the performance of cells through their enzymatic actions.

Grade Band Endpoints for LS1.A
By the end of grade 2. All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive, grow, and produce more plants.
By the end of grade 5. Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (Boundary: Stress at this grade level is on understanding the macroscale systems and their function, not microscopic processes.)

LS1.B: GROWTH AND DEVELOPMENT OF ORGANISMS
Source: National Academies Press
How do organisms grow and develop?

The characteristic structures, functions, and behaviors of organisms change in predictable ways as they progress from birth to old age. For example, upon reaching adulthood, organisms can reproduce and transfer their genetic information to their offspring. Animals engage in behaviors that increase their chances for reproduction, and plants may develop specialized structures and/or depend on animal behavior to accomplish reproduction. Understanding how a single cell can give rise to a complex, multicellular organism builds on the concepts of cell division and gene expression. In multicellular organisms, cell division is an essential component of growth, development, and repair. Cell division occurs via a process called mitosis: when a cell divides in two, it passes identical genetic material to two daughter cells. Successive divisions produce many cells. Although the genetic material in each of the cells is identical, small differences in the immediate environments activate or inactivate different genes, which can cause the cells to develop slightly differently. This process of differentiation allows the body to form specialized cells that perform diverse functions, even though they are all descended from a single cell, the fertilized egg. Cell growth and differentiation are the mechanisms by which a fertilized egg develops into a complex organism. In sexual reproduction, a specialized type of cell division called

meiosis occurs and results in the production of sex cells, such as gametes (sperm and eggs) or spores, which contain only one member from each chromosome pair in the parent cell.

Grade Band Endpoints for LS1.B
By the end of grade 2. Plants and animals have predictable characteristics at different stages of development. Plants and animals grow and change. Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive.
By the end of grade 5. Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles that include being born (sprouting in plants), growing, developing into adults, reproducing, and eventually dying.

LS1.D: INFORMATION PROCESSING
Source: National Academies Press
How do organisms detect, process, and use information about the environment?

An organism's ability to sense and respond to its environment enhances its chance of surviving and reproducing. Animals have external and internal sensory receptors that detect different kinds of information, and they use internal mechanisms for processing and storing it. Each receptor can respond to different inputs (electromagnetic, mechanical, chemical), some receptors respond by transmitting impulses that travel along nerve cells. In complex organisms, most such inputs travel to the brain, which is divided into several distinct regions and circuits that serve primary roles, in particular functions such as visual perception, auditory perception, interpretation of perceptual information, guidance of motor movement, and decision making. In addition, some of the brain's circuits give rise to emotions and store memories. Brain function also involves multiple interactions between the various regions to form an integrated sense of self and the surrounding world.

Grade Band Endpoints for LS1.D
By the end of grade 2. Animals have body parts that capture and convey different kinds of information needed for growth and survival—for example, eyes for light, ears for sounds, and skin for temperature or touch. Animals respond to these inputs with behaviors that help them survive (e.g., find food, run from a predator). Plants also respond to some external inputs (e.g., turn leaves toward the sun).
By the end of grade 5. Different sense receptors are specialized for particular kinds of information, which may then be processed and integrated by an animal's brain, with some information stored as memories. Animals are able to use their perceptions and memories to guide their actions. Some responses to information are instinctive—that is, animals' brains are organized so that they do not have to think about how to respond to certain stimuli.

LS3.A: INHERITANCE OF TRAITS
Source: National Academies Press
How are the characteristics of one generation related to the previous generation?

In all organisms, the genetic instructions for forming species' characteristics are carried in the chromosomes. Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. DNA molecules contain four different kinds of building blocks, called nucleotides, linked together in a sequential chain. The sequence of nucleotides spells out the information in a gene. Before a cell divides, the DNA sequence of its chromosomes is replicated and each daughter cell receives a copy. DNA controls the expression of proteins by being transcribed into a "messenger" RNA, which is translated in turn by the cellular machinery into a protein. In effect, proteins build an organism's identifiable traits. When organisms reproduce, genetic information is transferred to their offspring, with half coming from each parent in sexual reproduction. Inheritance is the key factor causing the similarity among individuals in a species population.

Grade Band Endpoints for LS3.A
By the end of grade 2. Organisms have characteristics that can be similar or different. Young animals are very much, but not exactly, like their parents and also resemble other animals of the same kind. Plants also are very much, but not exactly, like their parents and resemble other plants of the same kind.
By the end of grade 5. Many characteristics of organisms are inherited from their parents. Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment.

LS3.B: VARIATION OF TRAITS
Source: National Academies Press
Why do individuals of the same species vary in how they look, function, and behave?

Variation among individuals of the same species can be explained by both genetic and environmental factors. Individuals within a species have similar but not identical genes. In sexual reproduction, variations in traits between parent and offspring arise from the particular set of chromosomes (and their respective multiple genes) inherited, with each parent contributing half of each chromosome pair. More rarely, such variations result from mutations, which are changes in the information that genes carry. Although genes control the general traits of any given organism, other parts of the DNA and external environmental factors can modify an individual's specific development, appearance, behavior, and likelihood of producing offspring. The set of variations of genes present, together with the interactions of genes with their environment, determines the distribution of variation of traits in a population.

Grade Band Endpoints for LS3.B
By the end of grade 2. Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.
By the end of grade 5. Offspring acquire a mix of traits from their biological parents. Different organisms vary in how they look and function because they have different inherited information. In each kind of organism there is variation in the traits themselves, and different kinds of organisms may have different versions of the trait. The environment also affects the traits that an organism develops—differences in where they grow or in the food they consume may cause organisms that are related to end up looking or behaving differently.

Unit Overview: 1st Grade Inheritance Unit *Why does Creamsicle have cream fur?*

This guide is designed to be completed in 15 forty-five minute sessions (approximate times indicated below). Based on students' questions, experiences, and ideas, teachers may change lesson order or add in activities. To clarify, track lessons 2, 3, 5, and 6 on the classroom summary chart.
****Please note, the summary chart below is intended for teachers. The classroom summary chart entries should use more age-appropriate language. For ideas of what to include in the classroom summary chart, refer to the sample summary charts embedded in the lessons as a guide.*

AST Practice	Activity Name and Suggested Time	What students observe	What students learn	Connections to Creamsicle's fur color	Standards: NGSS
Eliciting students' ideas	**Lesson 1** ***Cat Exploration*** **Eliciting students' ideas** *45-60 minutes*	Students will observe pictures of different kinds of cats including wild and domesticated cats. Students will observe that all cats have some similarities and some differences. Students may have questions about the cats and their relationships which can be investigated during the unit.			CCC - Patterns
Eliciting students' ideas	**Lesson 2** **Puzzling Question Picture and Story** *Day 1: 45 min* *Day 2: 45 min*	Offspring cat has cream fur while both parents do not. The grandparent also has cream fur.	Families of cats can look similar and different than each other	Introduction to puzzling phenomenon and the story of Creamsicle the cat	SEP: Developing and using models
Supporting on-going changes in thinking	**Lesson 3** **Diagramming cat features and function** *45-60 minutes*	All cats share certain characteristics that have similar functions.	Each feature on a cat has a specific function that allows the cat to survive.	All cats have fur but the color of fur can vary. Creamsicle has cream fur and it is used to keep him warm and to protect his skin.	DCI LS1.A: Structure and Function LS1.D: Information Processing CCC - Structure and Function
Supporting on-going changes in thinking	**Lesson 4** **"Cat"egorizing Cats** *45-60 minutes*	There are many different looking cats, but they have similar features	Different cats share similar features based on how closely they are related and their geographical proximity.	Creamsicle looks similar to his parents and siblings because they are all closely related. When things are related they look similar but not identical.	CCC- Patterns
Supporting on-going changes in thinking	**Lesson 5** **Gene Simulation** *Day 1: 45 min* *Day 2: 45 min* *Day 3: 45 min* *Day 4: 45 min*	Students will see 50% of genes come from mom and 50% of genes come from dad Genes: set of invisible instructions that control our external and internal features.	Sometimes genes have instructions to make traits that are not expressed but the instructions can still be passed. This results in offspring having traits unique from their parents.	Genes from mom and dad can come in different combinations and leads to variation in offspring. Sometimes mom and dad can have traits that are present but not expressed. These "hidden" traits can be expressed in offspring if passed in a specific combination. Creamsicle got half of his genes from his mom and half from his dad. The combination of genes from each parent for fur color resulted in his cream fur.	SEP: Constructing explanations and designing solutions

Supporting on-going changes in thinking	**Lesson 6** **Gene Theater** *Day 1: 45 min*	Parents pass down half of their genes to their offspring	When genes are passed down, the selected genes are "chosen" at random.	Creamsicle got one gene for fur color from his mother and one gene for fur color from his father. The genes were chosen at random and resulted in Creamsicle's cream colored fur.	SEP: Constructing explanations and designing solutions. CCC: Patterns
Supporting on-going changes in thinking	**Lesson 7** **Track the Traits** *Day 1: 45 min* *Day 2: 45 min*	Students have one of two versions of several different traits. Some versions of a trait are more common than others.	Genes come in two forms. Sometimes, one form is present but not seen in the trait.	Creamsicle's siblings each have at least one gene for orange fur. Both of Creamsicle's genes must be for cream fur.	SEP: Constructing explanations and designing solutions CCC: Patterns
Pressing for evidence-based explanations	**Lesson 8** **Creamsicle Model** *Day 1: 45 min* *Day 2: 45 min*	Students have been revising their thinking about the unit phenomenon over time in light of new experiences, observations, and sense making talk that they have had throughout the unit activities. In this lesson, students will pull together what they have learned thus far in the unit by answering questions related to why Creamsicle has cream fur when his parents are orange furred and revising their original responses to questions on their initial model.			SEP: Constructing explanations and designing solutions
Supporting on-going changes in thinking.	**Lesson 9** **Cats in their Environment** *Day 1: 45 min*	Wild cats that live in cold climates have thick fur Wild cats that live in warm climates have thin fur. Wild cats that live in desert climates have large ears.	Cats have external features that are specific to the areas in which they live and help them survive in their environment. For example, thick fur acts to keep cats warm while thinner fur helps to keep cats cool. Fur color allows cats to camouflage in their environment which allows them to hunt better and avoid predation. Large ears allow cats to cool themselves.	These external features are as a result of their genes (the instructions inside their bodies) that they got from their parents. Like Creamsicle, wild cats get instructions (genes) from their parents that allow them to survive.	LS1.D Information Processing LS3.B: Variation of Traits CCC: Patterns
Supporting on-going changes in thinking	**Lesson 10** **Mom Knows Best** *Day 1: 45 min*	Moms and their kittens spend a lot of time together. In the beginning, kittens rely on their mothers to survive.	Cats have behaviors that allow them to survive. For example, feeding, play fighting, grooming, and meowing.	Cats and kittens, like Creamsicle, engage in behaviors that allow them to survive. Certain behaviors, such as hunting, exist in domesticated cats that never have to hunt. This is evidence that these behaviors, similar to visible features such as fur color, are influenced by genes.	DCI LS1.B Growth and Development of Organisms CCC: Patterns SEP: Obtaining, Evaluating, and Communicating Information
Engineering Solutions using evidence-based explanations	**Lesson 11** **Copy Cats** *45-60 minutes*	Cats use their tongues to groom themselves. Cats groom for several purposes including survival. Cat tongues must be able to remove all traces of food from their fur after eating to ensure they aren't hunted by predators.	Students will see how a cat's tongue is similar to a cleaning sponge Students will predict what type or side of sponge is most like a cat's tongue.	Students will test to see how the structure of the sponge (smooth or rough) affects its function (cleaning surfaces).	1-LS1-1 SEP: Constructing explanations and designing solutions CCC: Structure and Function

Lesson 1: CAT EXPLORATION

OBJECTIVES & OVERVIEW

Students will bring in a picture of a cat to share with the class. The teacher will post the pictures so that students can observe pictures of different kinds of cats including wild and domesticated cats. Students will note similarities and differences between the cats and participate in a discussion about the cats and what it means to be related.

Focus Question: What are some similarities and differences between different kinds of cats?

- Students will observe similarities and differences between different kinds of cats.
- Students will explain their thinking about what it means to be related.

Ambitious Science Teaching: ELICITING STUDENTS' IDEAS

Information gathered by eliciting all students' initial ideas about a scientific idea and making a public record of these can inform instructional decisions for upcoming lessons. For more information about these practices please visit: http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

Standards Note: Because this lesson is intended to elicit students' initial ideas and experiences, students will not entirely demonstrate the performance expectations (PE) listed here. Students will have additional opportunities in this unit to fully engage in the dimensions of the PEs below. However, students will use their prior experiences and their casual observations of how traits are passed to construct explanations (SEP) that can explain patterns (CCC) to begin to explain how traits are passed. Students are engaged in a three-dimensional performance.

PE 1-LS3-1 Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Constructing Explanations and Designing Solutions Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-LS3-1)	Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (1-LS3-1)	Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. (1-LS3-1) .

MATERIALS

For the class:

- Pictures of various wild cats (teacher prepared)
- Pictures of various domestic cats (teacher prepared)
- Pictures of cats (from students)
- Large place in the room to post the pictures
- Poster paper or orange butcher paper to record student responses

Per student:

- Homework sheet (Requesting students to bring in a picture of a cat prior to this lesson)

PREPARATION

Print cat pictures (see below for options)
Print homework sheet
Setup poster paper T-chart to record student responses on similarities and differences
(BEFORE THE DAY OF THE LESSON) Assign cat picture homework.
. Explain that students will be studying about cats for the upcoming science unit. You'd like students to bring in one picture of a cat. It can be a picture of their own cat, a picture from a magazine, a printed picture, etc. Any kind of cat is appropriate for this assignment.

PROCEDURE

Present Visuals

Show color photos of different kinds of cats

1. Activate prior knowledge and experiences (whole group)

Introduce this unit by telling students they will be learning about cats and their similarities and differences. Ask students to take out their cat pictures and share them with the class. This can be done one at a time. The teacher then posts the pictures in a visible spot in the classroom.

Option: Depending on the population of students, some teachers may want to provide a variety of pictures of different kinds of cats and ask the students to choose a picture to present. This may be an appropriate option if the students are unable to bring in pictures of cats on their own.

Option: After the students pictures have been posted, the teacher can add pictures of wild and/or domestic cats as needed to ensure a variety of different kinds of cats.

Turn-and-Talk

What do you see is the same between all these cats?
What do you see is different?

2. Record Observations

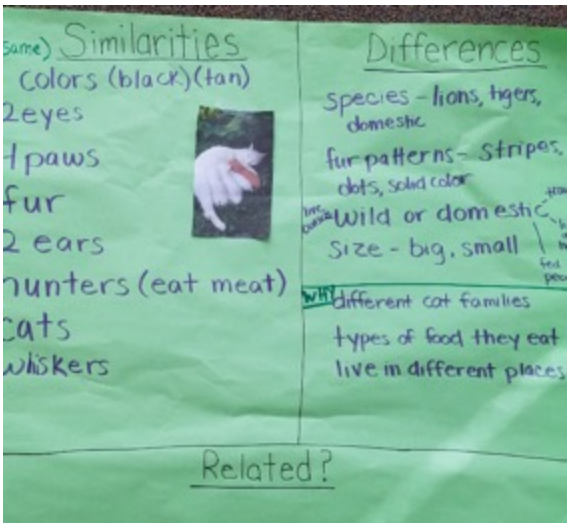
Together, as a class, make a list of observations about similarities and differences between the cats. Start with a turn-and-talk to have students share observations about what they notice.

See the charts below for examples. It is generated with input from students so lists of observations will vary.

Public Record

List of observations

Similarities (Same)	Differences (Different)
• 2 Ears • 4 Legs • Whiskers • Fur • 4 paws	• Ear shape / size • Leg length • Whisker length • Fur color • Paw size



Back-Pocket Questions

- *Are any of these cats related?*
- What does it mean to be related?
- How can you tell who is more closely *Why would cats have so many differences?*
- Why are there so many differences?

3. Summarize and whole class discussion

After students have generated the list of similarities and differences, ask them to think about the Back-Pocket-Questions on the left.

See the chart below for an example. It is generated with input from students so lists of observations will vary.

Our Ideas About Cats
• They are not related because they don't share mom and grandparents • They are not related because they live in different habitats • When you are related you share parents and grandparents • They are related because they are all part of the cat family

Teacher Note: You may also want to be responsive to students' emotional needs. Take time to explain to students that families can vary but all are accepted. Some students may be adopted, live with grandparents, have divorced parents, have same-sex parents, etc. Figuring out what family means in the context of this unit is important to understanding what students will be learning about.

Public Record

Our ideas about cats

EXAMINING STUDENT WORK

For this lesson, the teacher should use student discussions and examine the list of similarities and differences compiled by the students. This task is intended to help you notice what concepts students are already thinking about and which ones are new to most students. Are the students able to adequately identify similar characteristics that all cats share (i.e., fur, claws, whiskers, 2 ears, 4 legs, etc.)? Are the students able to adequately identify differing characteristics (i.e., fur color, tail length, ear size, etc.)? As well, teacher should reflect on student responses about what it means to be related. Do students have a sense of what this means? Are they able to make connections between similar features and being related? Do they recognize that more similar features indicate closer relationship that cats with more different features?

PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class decide what lesson(s) should come next. These lessons give students more information about ideas they shared to deepen their understanding or the lessons can help answer questions students posed. Additional lesson could be added or substituted based on the ideas and questions students have.

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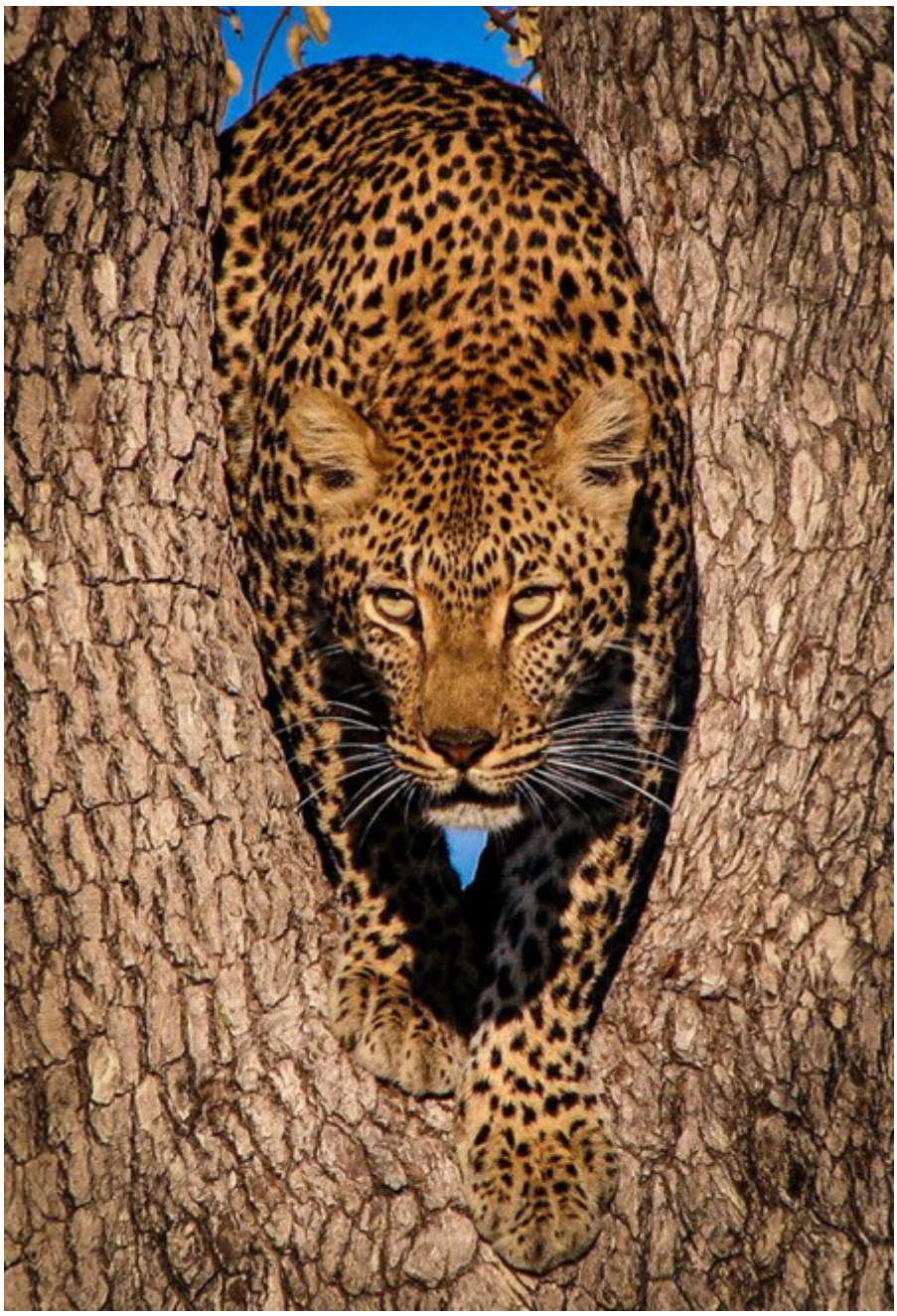
Optional computer extension: National Geographic Kids - "Which Wild Cat are You?"

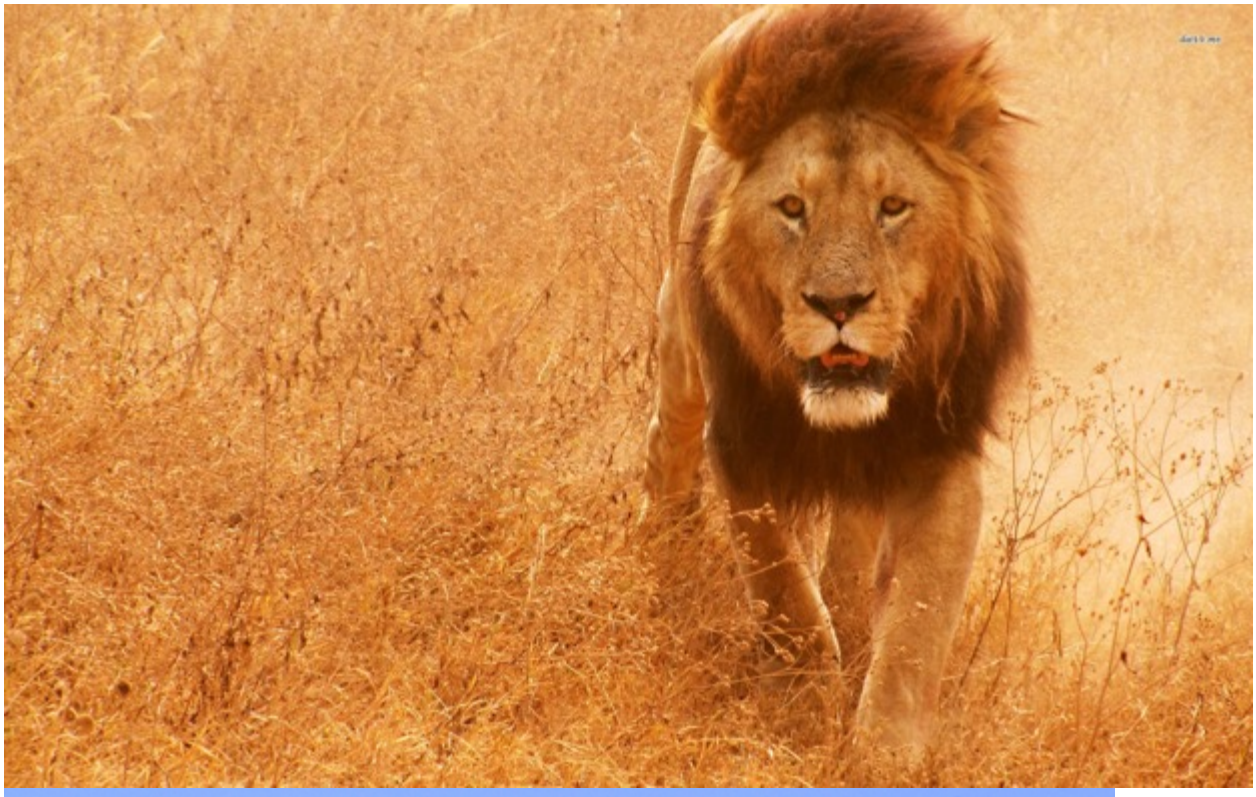
Crazy for Cats Homework

Directions: Bring in 1 picture of a cat by _____. This can be a picture from a magazine, printed off the internet, or from a personal collection. Any kind of cat is acceptable.

Here are some example cat pictures that can be printed and used in class. Make sure to include a variety of pictures of wild and domesticated cats to supplement student contributions.

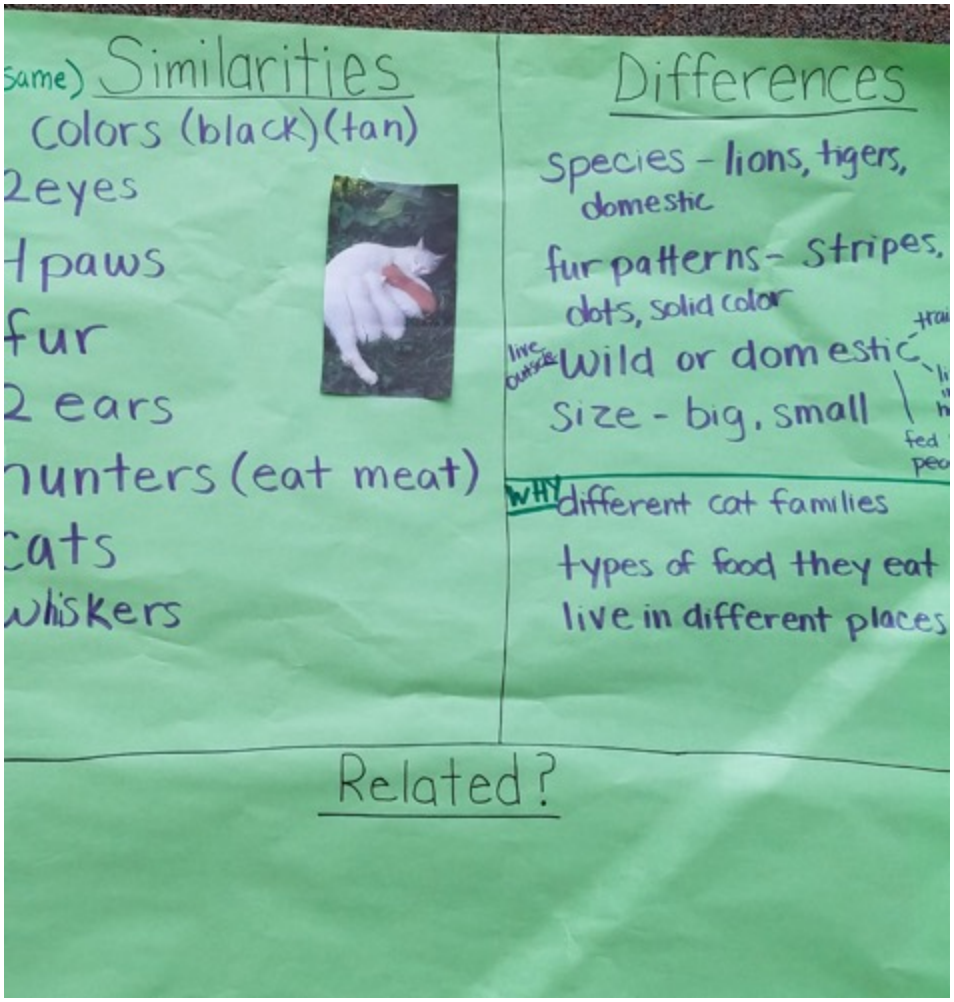



© Barcroft Media



Here is one example of the Cat Exploration poster. This includes pictures provided by the students and teacher.

Here is an example of the class generated list of similarities and differences between the different kinds of cats.



TEACHER REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

Keep a record of these reflections for your professional portfolio.

1. TASK, TALK, & TOOLS

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of identifying similarities and differences among cats helped students to/with…*
- *The task about _____ relates to students' and/or their families' lives because…*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked to each other during (name particular parts of lesson) which allowed students to…*
- *During turn-and-talks, I observed ____ which makes me wonder if/how…*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

- *The list of observations allowed students to…*
- *Creating a list of initial ideas about cats allowed students to…*

Overall, reflecting on task, talk, and tools together:

- *Talk, task, and tools supported students to share their thinking because…*
- *Overall, this combination of talk, task, and tools, allowed most/all students to…*

_____

_____

_____

2. EQUITY. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific issue of equity:

- *Developing relationships and forming an inclusive, trusting community*
- *Scaffolding for full participation in the culture and language of science*
- *Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs*
- *Addressing power dynamics (how a person is seem and responded to by others) to disrupt stereotypes and privilege*

_____

_____

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_____

Lesson 2: Family Story and Model

OBJECTIVES & OVERVIEW

Students will be introduced to the puzzling phenomenon and given a common experience for the unit. Students will use the story they hear to fill out the fur color for a family of cats. Students will be asked to think about, write, and share their ideas about how kittens from the same parents can look different and how a kitten can get cream fur if the parents' fur is orange.

Focus Question: Why does Creamsicle have cream fur?

- Students will explain why they think kittens from the same parents can look different.
- Students will explain how a kitten can have cream fur if both parents have orange fur.

Ambitious Science Teaching: Eliciting students' ideas

Information gathered by eliciting all students' initial hypotheses about a scientific idea, and making a public record of these can inform instructional decisions for upcoming lessons. For more information about these practices please visit: http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

Standards Note: Because this lesson is intended to elicit students' initial ideas and experiences, students will not entirely demonstrate the performance expectations (PE) listed here. Students will have additional opportunities in this unit to fully engage in the dimensions of the PEs below. However, students will use their prior experiences and their casual observations of how traits are passed to construct explanations (SEP) that can explain patterns (CCC) to begin to explain how traits are passed. Students are engaged in a three-dimensional performance.

PE 1-LS3-1 Make observations to construct evidence-based account that young plants and animals are like, but not exactly like their parents.

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Constructing Explanations and Designing Solutions - Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-LS3-1)	Young animals are very much, but not exactly like, their parents. Plants also are very much, but not exactly, like their parents. (1-LS3-1) Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (1-LS3-1)	**Patterns** • Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. (1-LS3-1)

Common Core Connections:
CCSS.ELA-LITERACY.RL.1.1: Ask and answer questions about key details in a text.
CCSS.ELA-LITERACY.RL.1.3: Describe characters, settings, and major events in a story, using key details.

PREPARATION

30 minutes

1. Materials preparation and set-up takes approximately 30 minutes and can be done the day before the lesson.
2. Create a family tree poster of Creamsicle's family tree. Affix the pictures on a large classroom poster so that each picture can be lifted to reveal the gene combination for each cat in future lessons. See below for some poster options:

In the above family tree poster example, the teacher has used generic cat outlines that are colored to match the phenomenon. As well, the gene squares are colored in on the front.

You can also use pictures of the actual cats that are affixed to the poster at the top of each picture so that they can be lifted to reveal the gene squares underneath. (See the picture below – these pictures would need to be printed, cut out, and attached to a poster with the gene squares information listed underneath).

***Keeping the gene squares hidden beneath the pictures helps students understand that our genes are present and influence our traits but are not themselves visible from the outside.*

MATERIALS

For the class:

- Copy of story "Meet Creamsicle" to read to students
- Classroom copy Family Tree

Per student:

- Model scaffold sheet on 11"x17" paper
- Pencil
- Colored Pencils or crayon

PROCEDURE

Turn and Talk

What do you notice about the fur color of the cats in this family?

1. **Activate prior knowledge and experiences (whole group)**
   a. Introduce this lesson by revisiting student observations about relationships between cats as well as their ideas about what it means to be related.

Sensitivity Note for Teacher: Be aware and sensitive around conversations about relatedness and passing on traits. Students might bring up they look like their dad, grandpa, etc… while others may not know or wish to talk about this.

2. **Introduce the phenomenon (whole class)**
   a. Tell students they are going to learn about a family of cats. They need to make observations as they look at the picture of Creamsicle and his siblings. They will also need to color in details about Creamsicle and his family as they listen to the story, "Meet Creamsicle."

Public Record

Observations about Creamsicle's family

3. **Record observations about the phenomenon (whole class)**
   a. Together, as a class, make a list of observations from the picture of Creamsicle and his family. Start with a turn-and-talk to have

students share what they see in the picture.

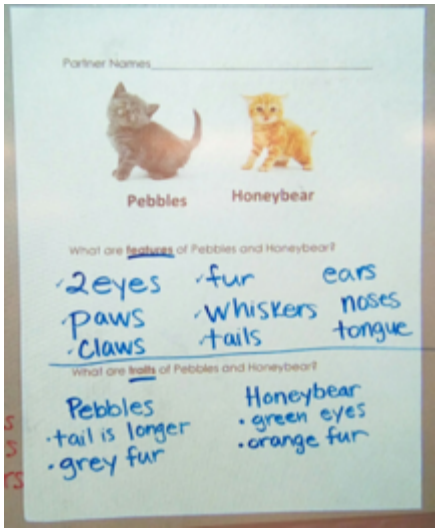
This is the picture of Creamsicle and his family to use during this activity.

See the chart below for an example. It is generated with input from students so the lists may vary.

Our Observations about Creamsicle's Family

- More orange than cream cats
- Both of Creamsicle's parents have orange fur
- Creamsicle has cream fur
- All of Creamsicle's siblings have cream fur

See the chart below for another example. It is generated with input from students using an alternative phenomena so the list may vary.



Public Record

Family Tree - Colored

Back-Pocket Questions

- *Where do you think cats get their fur color from?*
- Why are there different colors of fur in the same family?
- *How do you think cats with orange fur had a kitten with cream fur?*
- Why do you think the kittens look different?

Whole Class Discussion

4. **Develop Initial Models (individual)**
   a. Show the students the model scaffold and explain that they will fill in the family tree with details they hear from the story, "Meet Creamsicle."
   b. Read "Meet Creamsicle" to students and have students color the cats on the model that are described in the story.
      i. Pause after each key detail and ask students if they learned anything about the family.
      ii. Model coloring in the traits students talk about.

5. **Continue to develop models (individual)**
   a. After the family tree is completed, read over the 3 questions on the model as a class. Partner students and have them discuss the questions and write their responses on their model sheet.
   b. Circulate as students are working. Interact with students asking them about their ideas. Some possible questions are listed to the left.

6. **Summarize and select ideas to make public (whole class)**
   As students work on their models, circulate and observe the kinds of ideas students have. Select 2 or 3 students (or pairs) to share out one of their ideas about Creamsicle. Select students who have different ideas.

   Have these students show their model under the document camera and explain their idea(s) to the class.

   Encourage students to have a short discussion about their initial ideas to make sure we all understand each other's' ideas. This is a time for clarifying and elaborating about ideas, not for debating or argumentation (this can come later when students have more evidence from the activities).

Students can use prompts like:

- Why do you think that (asking for evidence/experience)
- Your idea makes me wonder if (posing a question)
- I agree but I said/showed that idea by…(comparing models)

Allow students to continue to work on their models answering the questions for a few more minutes. They can incorporate some ideas they just heard if agree.

7. Pressing for possible explanations: Create a hypothesis list (whole class)

Have students share out their ideas with each other before writing a list to allow students to hear the different ideas.

Then generate a list with students by having them write ideas on sticky notes. If helpful, students could use this sentence starter:

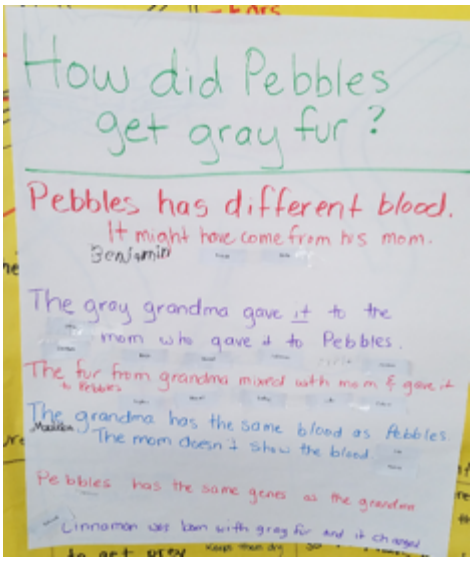
I think Creamsicle has cream fur because…

Here are two examples of student generated hypothesis. These ideas were explored throughout the unit (including one unit with an alternative phenomenon). Ideas will vary

<u>What Caused Creamsicle's Cream Fur?</u>

Hypotheses: Our Initial Ideas

- Creamsicle has cream fur because his grandmother gave it to him
- Fur color just happens - it doesn't matter what your parents look like
- The cream fur was hiding and came out in Creamsicle



EXAMINING STUDENT WORK

Use students' models and discussions to track students' initial understanding. This task is intended to help you notice what concepts students are already thinking about and which ones are new to most students.

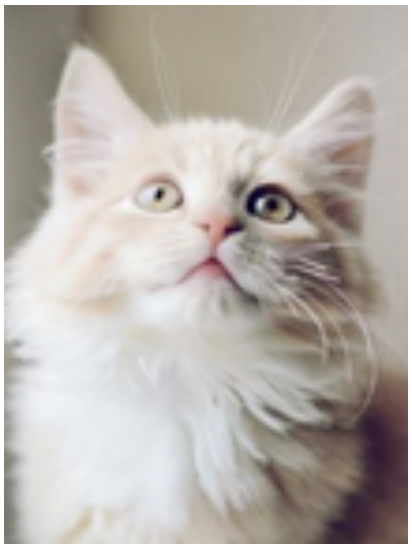
PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class and from their models decide what lesson(s) should come next. These lessons give students more information about ideas they shared to deepen their understanding or the lessons can help answer questions students posed. Additional lesson could be added or substituted based on the ideas and questions students have.

_____
_____
_____
_____
_____

Creamsicle's Family Photos

Pearl
(maternal grandmother)



Flame
(maternal grandfather)

Peaches
(Paternal Grandmother)

Pumpkin
(Paternal Grandfather)

Cinnamon (Mother)

Orange Star (Father)

Creamsicle

Honeybear (sister)

Chili (brother)

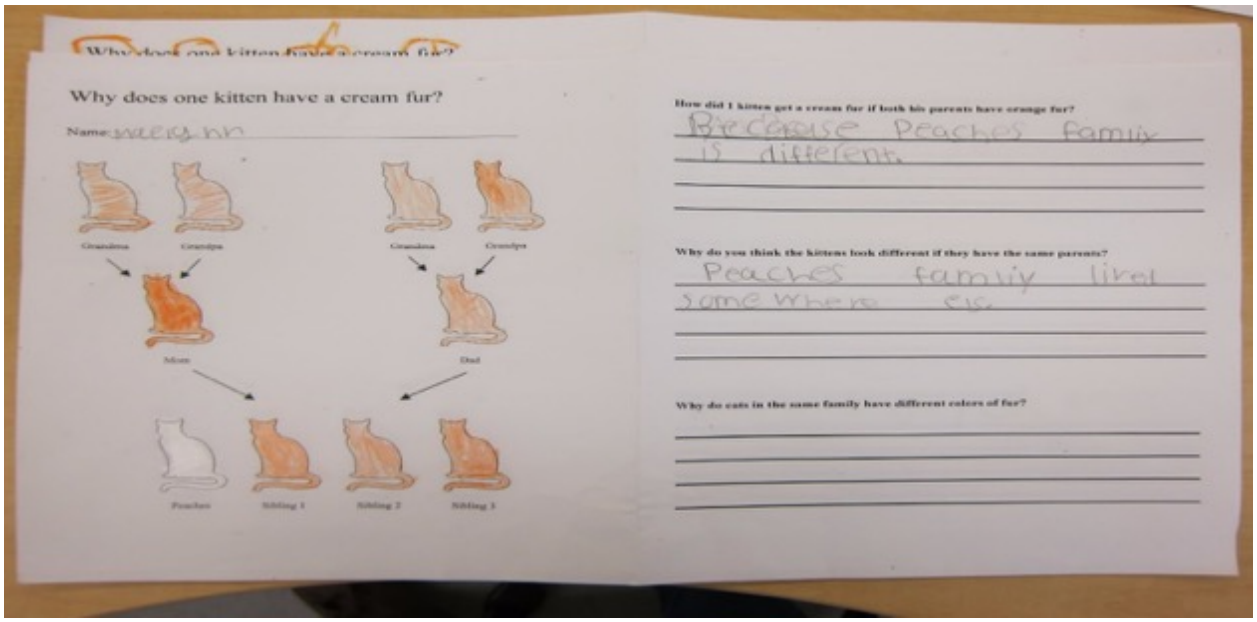
Blaze (brother)

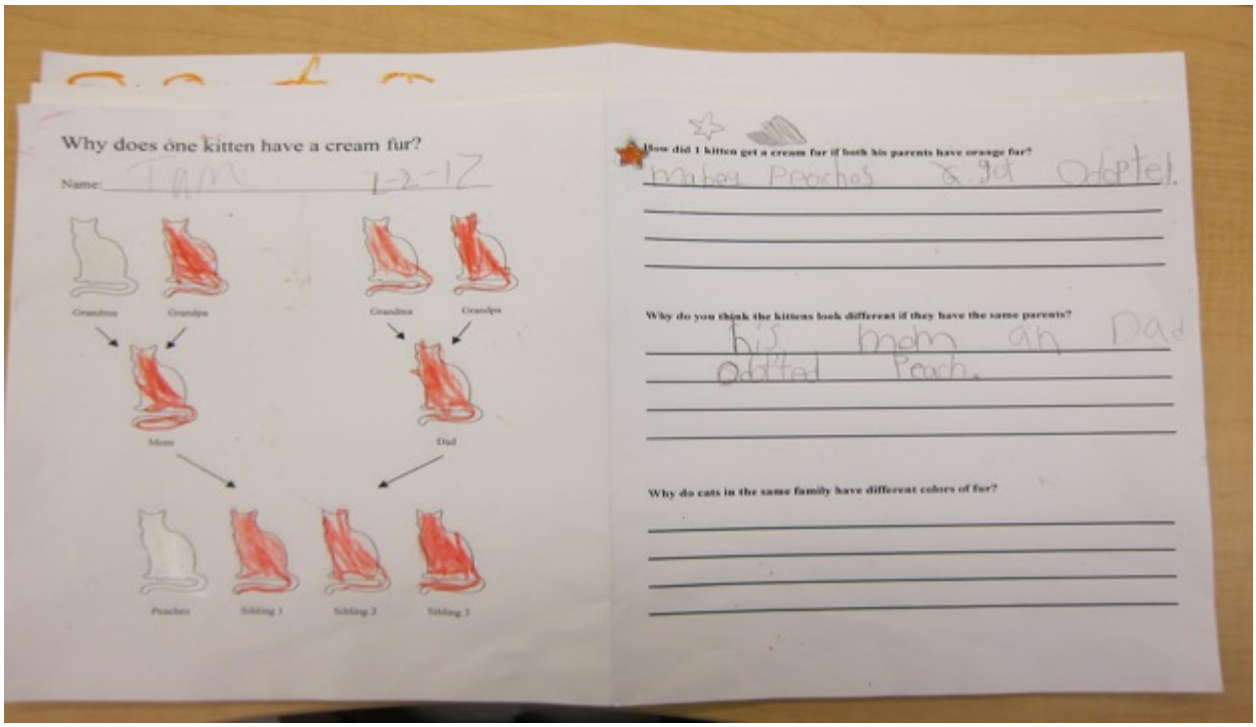
"Meet Creamsicle: The Little Cream Kitten"

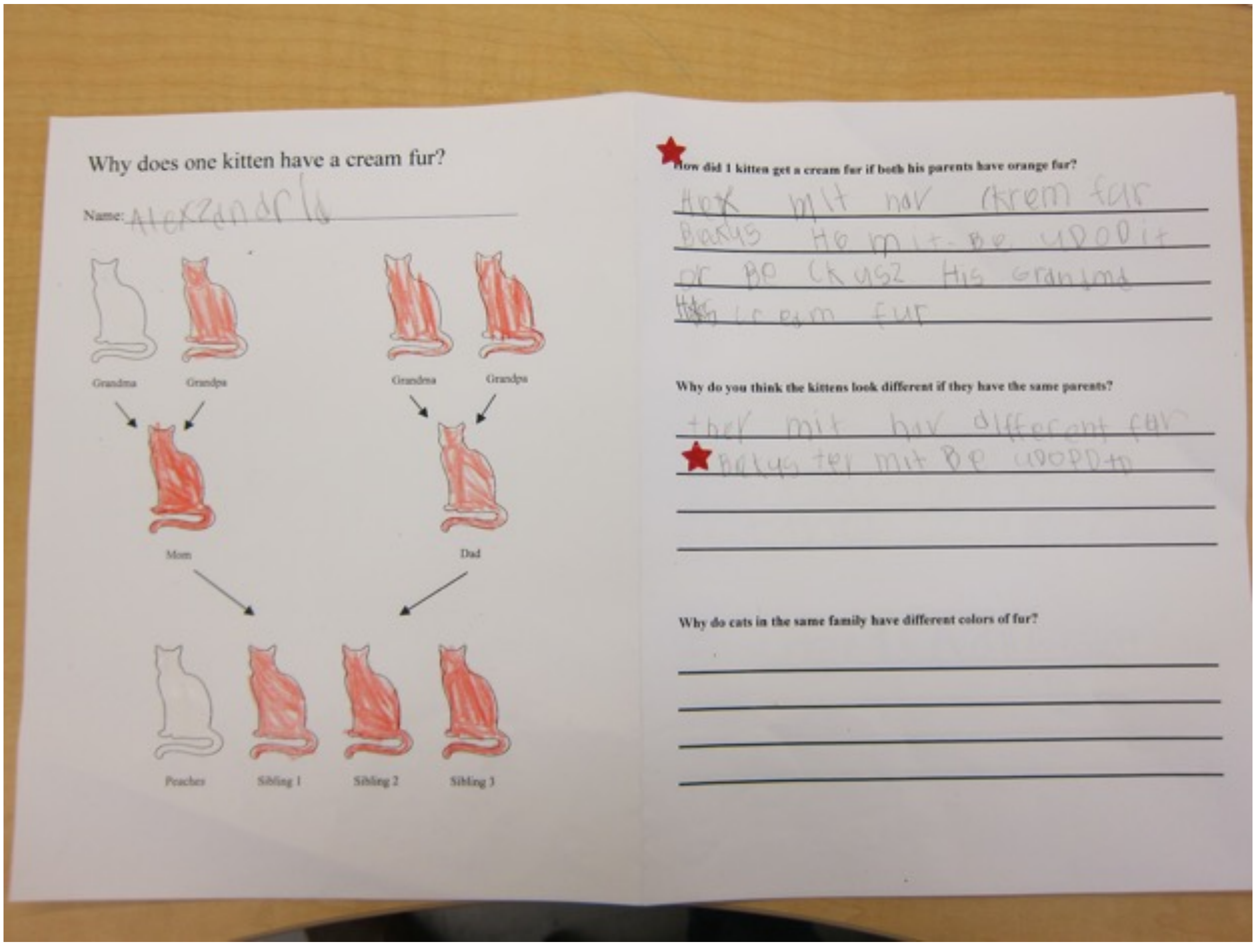
Vivian, Jose, Zamen, and Kuan are studying how traits are passed in families. They have been assigned, as a team, to investigate and report on the family traits of an animal one of them owns. They have decided to learn about Vivian's kitten, Creamsicle, and have met at her family's home.

Vivian: This is my kitten, Creamsicle. I like him because he looks different than his siblings.
Zamen: Yes. His fur is cream but his siblings all have orange fur.
Kuan: I notice that Creamsicle has green eyes. His sister, Honeybear, has green eyes and his two brothers, Chili and Blaze, have green eyes.
Jose: I see that Creamsicle has a shorter tail than his siblings but they all have long fur.
Vivian: One thing that doesn't show just by looking at him is his friendly personality.
Jose: Vivian, do you know who Creamsicle' mother and father are?
Vivian: Yes, his mother is right over there. Her name is "Cinnamon."
Kuan: Her fur is long and orange.
Zamen: Her eyes are green.
Jose: What is her personality like, Vivian?
Vivian: She is very friendly.
Kuan: Who is Creamsicle's father, Vivian?
Vivian: His father is "Orange Star". He lives with another family. He's a very calm and friendly cat. He also has long orange fur.
Zamen: What color are his eyes?
Vivian: He has green eyes too.
Zamen: Then why does Creamsicle have cream fur?
Vivian: I'm not sure. But I do know his mom's mom, named Pearl, had cream fur.
Kuan: That's unexpected. Why would Creamsicle have cream fur if his grandma has cream fur but his parents both have orange fur?
Jose: That's a great question. Let's see if we can figure it out.

Here are three examples of 1st grade students' initial models. In the examples below, the teacher called the cream kitten in generation three "Peaches."






Why does one kitten have a cream fur?
Name:
Grandma
Grandpa
Grandma
Grandpa
Mom
Dad
Peaches
Sibling 1
Sibling 2
Sibling 3
How did 1 kitten get a cream fur if both his parents have orange fur?
Why do you think the kittens look different if they have the same parents?
Why do cats in the same family have different colors of fur?

Creamsicle's Family Tree

Pearl

Grandmother

Grandfather

Cinnamon

Orange Star

Creamsicle

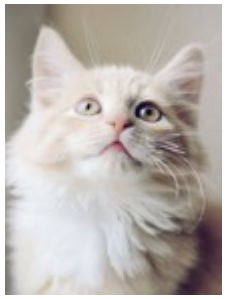
Honeybear

Chili

Blaze

WHY DOES CREAMSICLE HAVE CREAM FUR?

Creamsicle's Family Tree



Pearl

Flame

Peaches

Pumpkin

Cinnamon

Orange

Creamsicle

Honeybear

Chili

Blaze

TEACHER REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

1. **TASK, TALK, & TOOLS**

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of hypothesizing about a phenomenon helped students to/with…*
- *The task about _____ relates to students' and/or their families' lives because...*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked to each other during (name particular parts of lesson) which allowed students to…*
- *During turn-and-talks, I observed ____ which makes me wonder if/how...*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

- *The model scaffold tool allowed students to…*
- *Creating a list of initial ideas allowed students to...*

Overall, reflecting on task, talk, and tools together:

- *Talk, task, and tools supported students to share their thinking because…*
- *Overall, this combination of talk, task, and tools, allowed most/all students to...*

_____

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EQUITY. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific issue of equity:

- *Developing relationships and forming an inclusive, trusting community*
- *Scaffolding for full participation in the culture and language of science*
- *Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs*
- *Addressing power dynamics (how a person is seem and responded to by others) to disrupt stereotypes and privilege*

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Lesson 3: Cat Diagram

OBJECTIVES & OVERVIEW

Students will label a cat diagram with key features and the purpose of each feature. This allows/exposes students to all the same vocabulary and creates a record for students to refer back to.

Focus Question: What is the job of each cat feature and how do they use these features to survive?

- Students will create a labeled diagram of the key features of a cat.
- Students will record the purpose of each feature to support them in later discussions.

Ambitious Science Teaching: SUPPORTING ON-GOING CHANGES IN STUDENT THINKING

This practice supports on-going changes in student thinking, introducing shared key vocabulary and ideas with which to reason.
For more information visit http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

Standards Note: In this lesson students are beginning to make observations about the features and functions of cat features. They will not fully demonstrate the features of the performance expectations (PEs) below. They will have more opportunities to fully engage in the dimensions of the PEs listed.

Students who demonstrate understanding can:

1-LS1-1. **Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.*** [Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Constructing Explanations and Designing Solutions: Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-LS3-1)	All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow.	**Structure and Function:** The shape and stability of structures of natural and designed objects are related to their function(s).

MATERIALS

For the class:

- Poster Markers
- Class poster of cat diagram- to leave on wall

Per student:

- Cat diagram
- Colored markers (optional - see note)

PREPARATION

15 minutes

1. Trace cat diagram to poster paper by projecting cat diagram (15 min)

PROCEDURE

Public Record

Cat Diagram

1. **Activate prior knowledge and experiences (whole class).**
   a. Introduce this lesson by revisiting ideas students had in lesson 1 about similarities and differences between cats. Point to comparisons related to external cat features from lesson 1 and tell students that today they will be labeling 8 key features on a cat diagram.
   b. Have students turn-and-talk about their knowledge of cat anatomy.
2. **Getting the Activity Started (whole class)**

. Show the class cat diagram and pass out individual cat diagrams to each student.
   a. The teacher should label the 8 key features on the cat diagram using student input. Allow time for students to make their own copy of the diagram to use a reference for features and spelling.

OPTIONAL: Write each feature in a different color. Later in step 3, write the corresponding purpose in the same color. This can help, especially with visual learners and ELL students, to track and match the feature with its purpose.

1. Ears
2. Eyes
3. Whiskers
4. Tongue
5. Tail
6. Fur
7. claws

2. **Share ideas and make predictions (small group)**

Students will turn-and-talk about what they think is the purpose of each cat feature.

Focus Question: What is the job of each cat feature and how do these features help cats survive?

Turn-and-Talk

What do you think each of these features is used for?

**You can have each group talk about all 8 features or assign different partners 1 word and have them share out with the class.

Back-Pocket Questions

Back-Pocket Questions:

- What does hearing allow cats to do?
- Why is good hearing important for cats?
- What does seeing help cats do?
- What do you think is the most important feature for a cat? WHY?
- Why do you think cats have different lengths of fur?]
- Do you think cats with longer hair stay warmer?

a.

Public Record

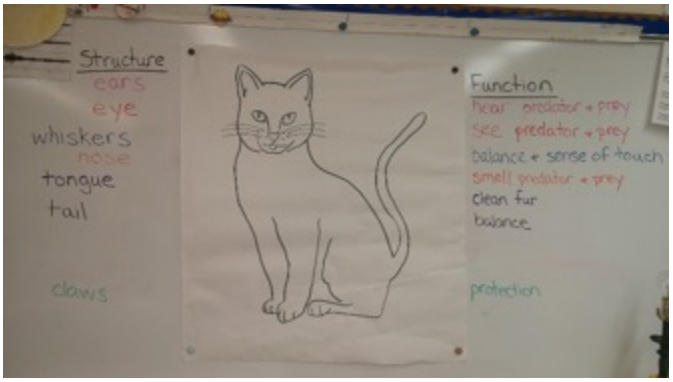
Cat Diagram

3. Publicly Sharing Ideas (Whole Group)

a. Write down the purpose of each feature and give time for students to write these down on their diagram as well.

b. Call on students to help fill out the purpose of each feature.

1. Ears- hear
2. Eye- see
3. Whiskers- balance, sense of touch
4. Tongue- clean fur
5. Tail- balance
6. Fur- keep warm, protect skin
7. Claws- protection, catch prey



Public Record

Summary Table

5. Publicly sharing ideas on summary table (whole group)

a. Record observations about cat features on the summary table under "what did we observe" column.

b. Record the purpose of each cat feature in the "what did we learn" column.

c. Record student ideas about the connections between this lesson and Creamsicle's fur color. If students are new to this exercise, they may need some leading to make connections between Creamsicle and all cats, as well as between Creamsicle's cream fur and its purpose.

Activity	***What did we observe?***	***What did we learn?***	***How does it help us explain Creamsicle's fur color?***
Cat Diagram (Sketch activity or past photo taken during activity here)	All cats share some common features (two ears, two eyes, 4 legs, etc)	Each feature on a cat has a special job that helps the cat survive • Tail is used for balance • Ears are used for hearing	All cats have fur but the color of fur can vary. Creamsicle has cream fur and it is used to keep him warm and to protect his skin.

EXAMINING STUDENT WORK

Use science talk about cat features and functions to assess students' understanding of the connections between features and functions.

TEACHER REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

Keep a record of these reflections for your professional portfolio.

TASK, TALK, & TOOLS

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of identifying cat features and functions helped students to/with…*
- *The task about _____ relates to students' and/or their families' lives because...*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked to each other during (name particular parts of lesson) which allowed students to…*
- *During turn-and-talks, I observed ____ which makes me wonder if/how...*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

- *The cat diagram with features and functions allowed students to…*

Overall, reflecting on task, talk, and tools together:

- *Talk, task, and tools supported students to share their thinking because…*
- *Overall, this combination of talk, task, and tools, allowed most/all students to...*

_____

_____

_____

.**EQUITY**. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific issue of equity:

- *Developing relationships and forming an inclusive, trusting community*
- *Scaffolding for full participation in the culture and language of science*
- *Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs*
- *Addressing power dynamics (how a person is seem and responded to by others) to disrupt stereotypes and privilege*

_____

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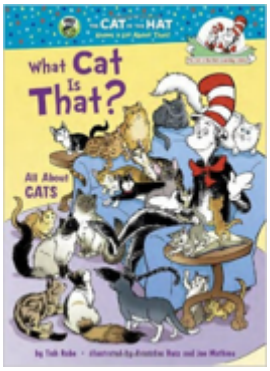
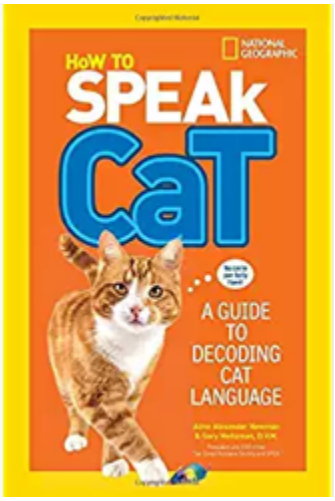
PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class decide what lesson(s) should come next. If students are still wondering about cat features and functions, you may consider adding an additional lesson to be responsive to students' questions and help them build their understanding.

OPTIONAL SUPPLEMENTAL READING:
What Cat Is That?: All About Cats (Cat in the Hat's Learning Library)



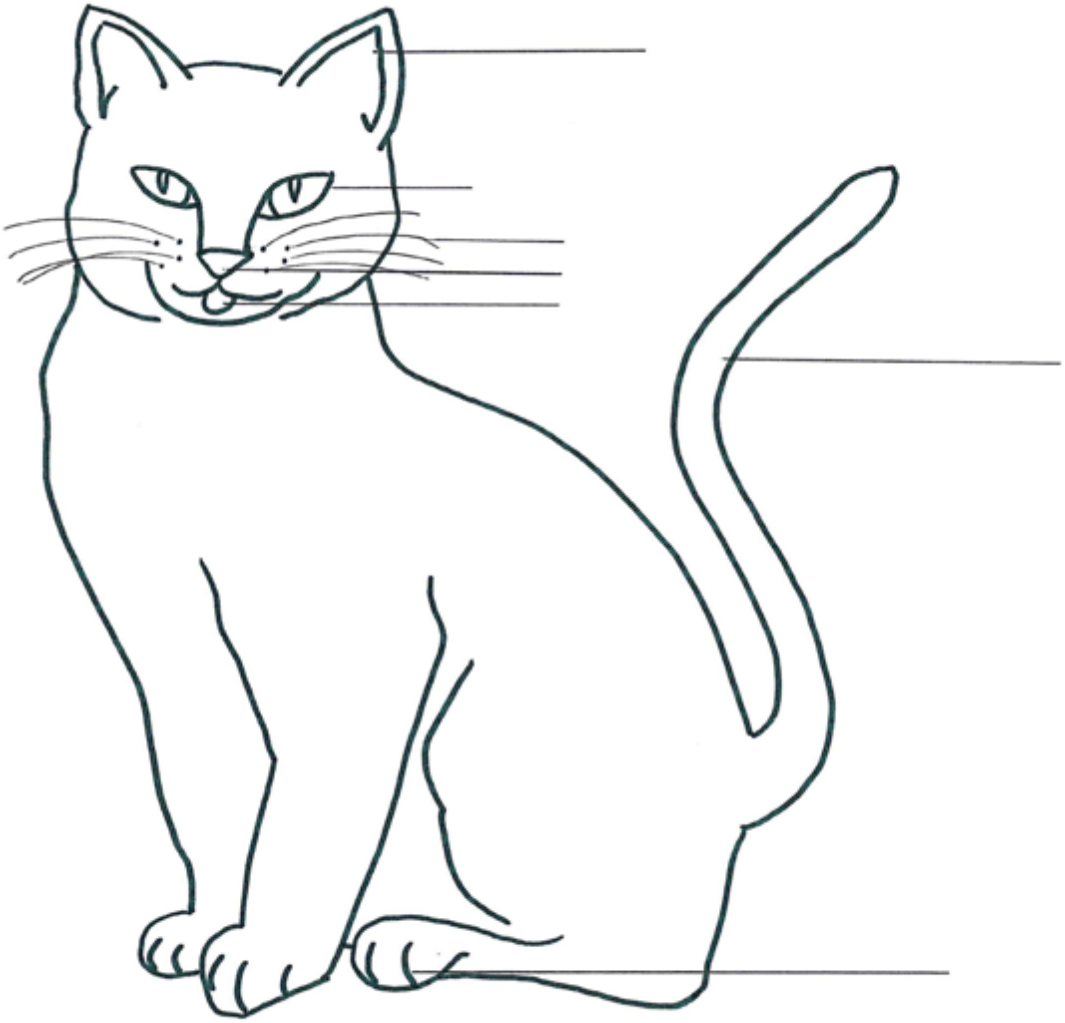
How to Speak Cat: A Guide to Decoding Cat Language



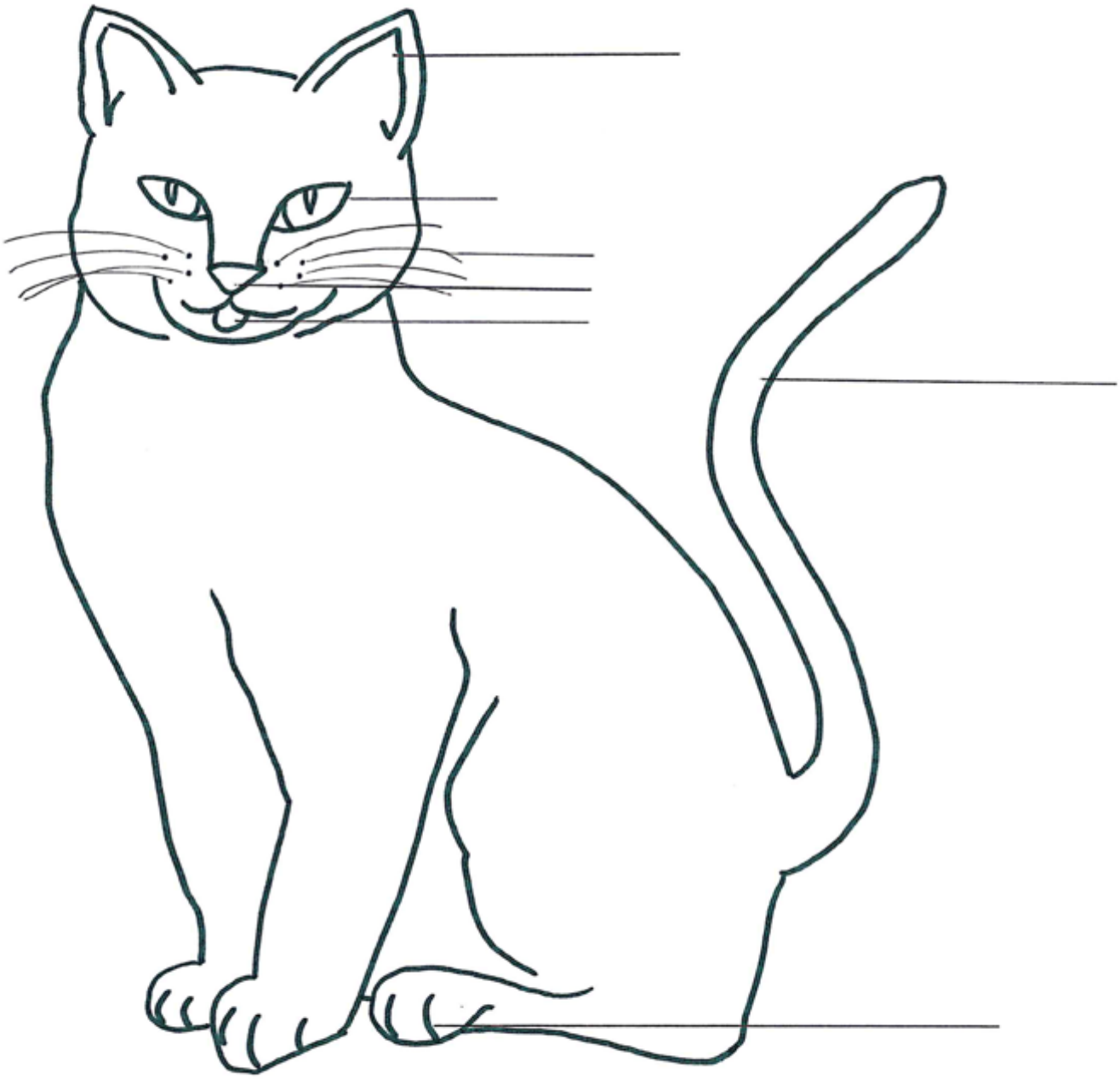
Name: _____

Cat Diagram

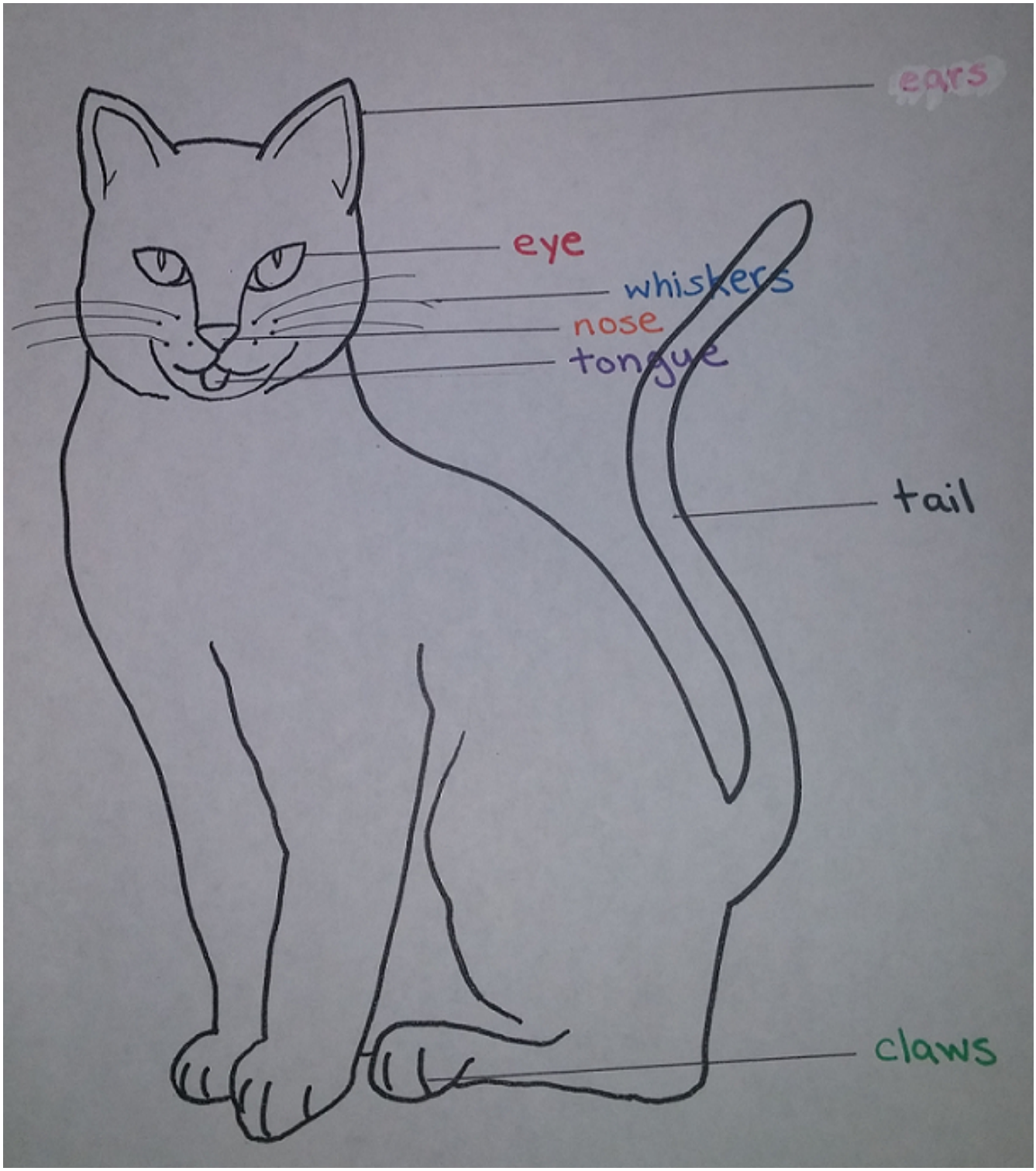
Directions: Label all of the cat features on the cat diagram below.



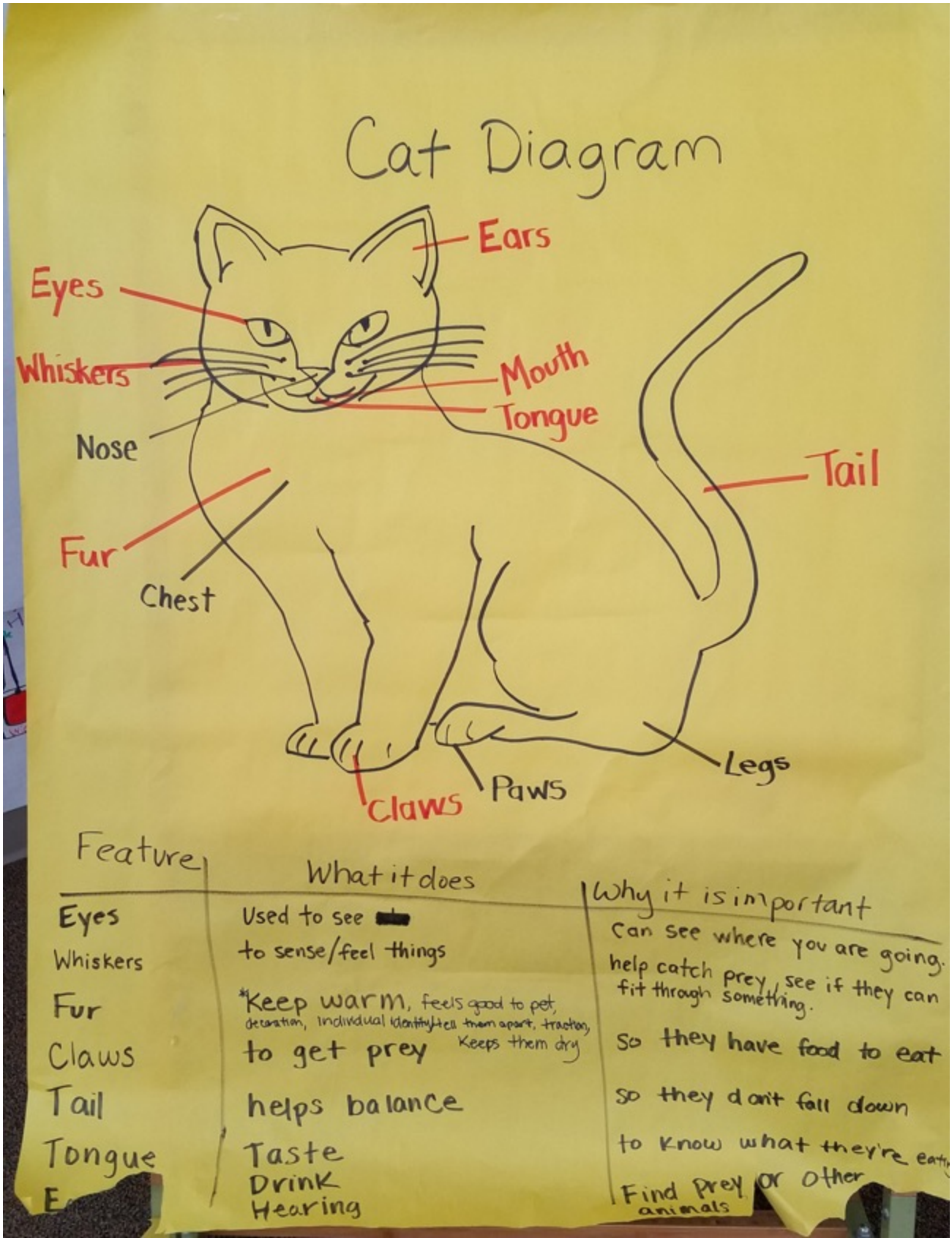
Cat Diagram - Classroom Poster



Cat Diagram - Labeled Features

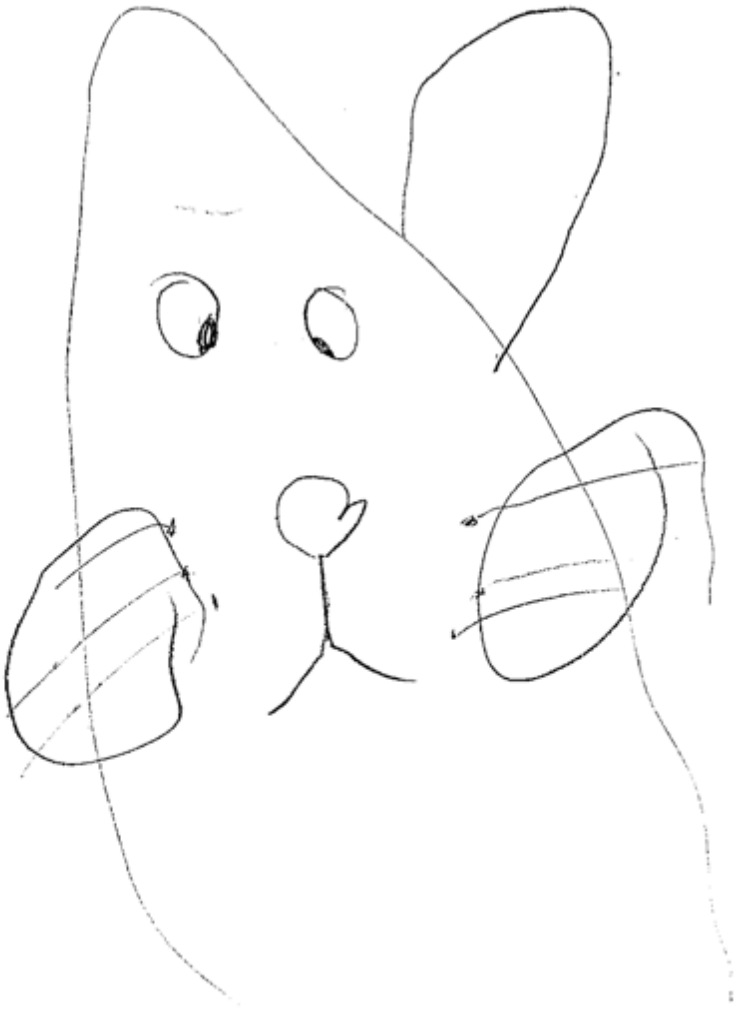


Here is an example of a completed cat poster including parts, functions, and why the parts are important.



Here are some examples of student Cat Diagrams. For this lesson, students were asked to label the cat features and to explain one feature and how the cat uses it for survival.

they use them whiskers to find stuff
because they use ther fer to feel
stuff ther whiskers are like are
skin




Cat Diagram
this Cat Loves
Mr. Grahams Boys
Wiskers
She is at a Birthday Party
tail
Ear
eyes
mouth
tongue
chest

imagine
Being a wild Cat
You Could Not
Balince ona
Branch
without
a tail

Lesson 4: "CAT"EGORIZING CATS

OBJECTIVES & OVERVIEW

This lesson gives students the opportunity to talk more about what makes cats similar and what makes them different. Using these ideas, students will then categorize the cats into groups of their choosing based on the similarities and differences they observe. Students will likely use the external features to determine which cats are most like each other and may make connections to the cats' habitats.

Focus Question: Why are some cats more similar than others?

- Students make and share observations about the similarities and differences between different kinds of cats.
- Students categorize pictures of cats based on similar characteristics.

Ambitious Science Teaching: ELICITING STUDENTS' IDEAS

Information gathered by eliciting students' ideas about categorizing cats can inform instructional decisions for upcoming lessons. For more about these practices please visit: http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

Standards Note: Because this lesson is intended to elicit students' initial ideas and experiences, students will not entirely demonstrate the performance expectations (PE) listed here. Students will have additional opportunities in this unit to fully engage in the dimensions of the PEs below. However, students will use their prior experiences and their casual observations of how traits are passed to construct explanations (SEP) that can explain patterns (CCC) to begin to explain how traits are passed. Students are engaged in a three-dimensional performance.

PE 1-LS3-1 Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Constructing Explanations and Designing Solutions: Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-LS3-1)	Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (1-LS3-1)	Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. (1-LS3-1) .

MATERIALS

For the class:

- Pictures of wild and domestic cats from first lesson posted on the wall

Per Student (or pair - see teacher decision point)

- Sets of 10 (+) pictures of wild and domestic cats
- 1 Poster paper with markers
- Glue or tape

Teacher Decision Point

Decide if students will categorize pictures in individually or in pairs.

Individual:

- Can assess individual student thinking
- Less student talk occurs naturally

Pairs:

- More talk as they negotiate how to categorize pictures
- Strategic partners benefit English Learners or those in need of writing support
- Can assess pairs' thinking

PREPARATION

Print sets of 10 pictures of wild and domestic cats - 1 per each student or group

PROCEDURE

Turn and Talk

Which cats seem to be the most similar?

1. **Activate prior knowledge and experiences (whole class)**
   Introduce this lesson by revisiting observations students had from lesson 1 about the similarities and differences between the different kinds of cats. Then have students turn-and-talk about which types of cats are most similar.

   Have students share out a few of their ideas and introduce the idea of categories.
   Focus question: Why are some cats more similar than others?

Small Group Work

2. **Getting the activity started (whole class)**
   Ask students to work as a team to put the cat pictures into 2 or more categories. Explain that the cats should be grouped in categories based on similarities. Once the students have chosen groups, the pictures should be affixed to a poster for presenting. If possible, students should label the names of their categories.

See the chart below for an example of possible categories. It is generated with input from students so lists of observations will vary.

Possible *Cat*egories	
Wild Cats	Domestic Cats
Big	Small
Warm Climate	Cool Climate

3. Make observations and uncover patterns using questions (small groups)

a. Circulate as students make observations and talk about how to categorize the pictures.

b. As the students make observations, circulate and ask questions about observations and patterns.

Back-Pocket Questions

- *What makes the cats in this group similar?*
- *Do you think the cats are related? How do you know?*
- *How are they different from the other group?*
- *Why would cats have so many differences?*
- *Where in the world might these cats live?*
- *Why do you think these cats have*

Whole-class discussion

Compare Charts

4. Summarize and select ideas to make public (whole class)

As students work on their categories, circulate and observe the kinds of ideas students have. Select 2 or 3 students (or pairs) to share out the categories they chose. Select students who have different ideas.

Have these students show their poster in front of the class and describe their idea(s) to the class.

Encourage students to have a short discussion about their categories to ensure that all understand each other's ideas. This is a time for clarifying and elaborating about ideas, not for debating or argumentation.

Students can use prompts like:

- *Why do you think that?* (asking for experience/evidence)
- *Your idea makes me wonder if…* (posing a question)

- *I agree but I thought of the categories this way…* (comparing charts)

Allow students to continue working on charts (taping pictures and writing category titles) for a few more minutes. They can incorporate some ideas they just heard if they agree.

Activity	***What did we observe?***	***What did we learn?***	***How does it help us explain Creamsicle's fur color?***
Categorizing Cats	There are many different kinds of cats.	Cats that are more closely related look more similar. Cats that live in similar environments look more similar.	Creamsicle looks similar to his parents and siblings because they are all closely related. When things are related they look similar but not identical.

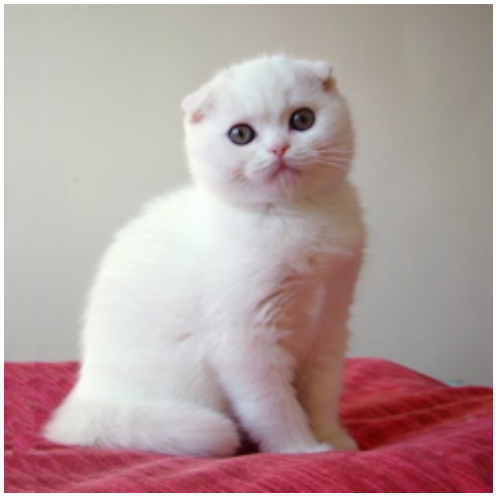
EXAMINING STUDENT WORK

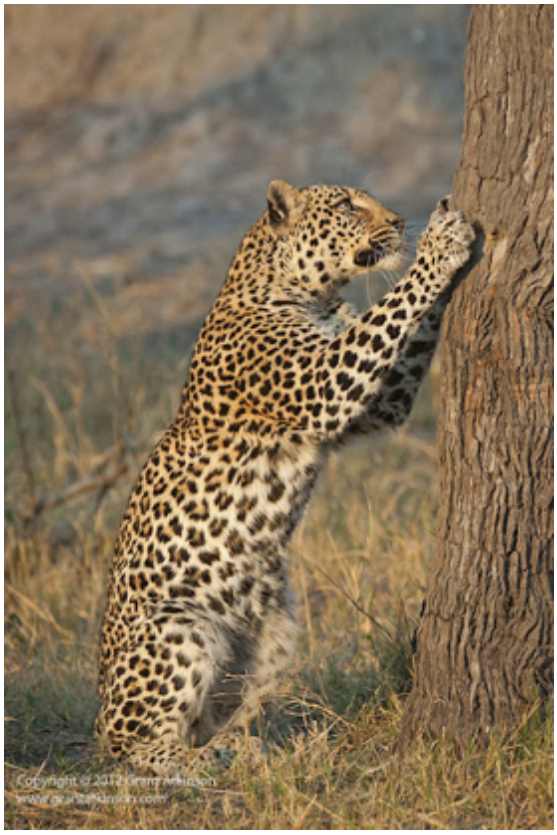
For this lesson, the teacher should use student discussions and posters to track students understanding of cat relations and the general notion of relatedness. This task is intended to help you notice what concepts students are already thinking about and which ones are new to most students.

PLANNING NEXT STEPS

Using ideas and questions you have heard from students during class decide what lesson(s) should come next. What questions do students have that could anchor future lessons? What lessons might need to be added to help students build their understanding.

CATegorizing Cats Student Pictures





TEACHER REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

Keep a record of these reflections for your professional portfolio.

1. TASK, TALK, & TOOLS

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of identifying cat features and functions helped students to/with…*
- *The task about _____ relates to students' and/or their families' lives because…*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked to each other during (name particular parts of lesson) which allowed students to…*
- *During turn-and-talks, I observed ____ which makes me wonder if/how…*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

- *The back-pocket questions allowed students to…*

Overall, reflecting on task, talk, and tools together:

- *Talk, task, and tools supported students to share their thinking because…*
- *Overall, this combination of talk, task, and tools, allowed most/all students to…*

_____

_____

_____

EQUITY. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific issue of equity:

- *Developing relationships and forming an inclusive, trusting community*
- *Scaffolding for full participation in the culture and language of science*
- *Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs*
- *Addressing power dynamics (how a person is seem and responded to by others) to disrupt stereotypes and privilege*

_____

_____

_____

_____

_____

Lesson 5: Gene Simulation 1

OBJECTIVES & OVERVIEW

Students will model that 50% of genes in a kitten come from mom and 50% come from dad. Students will also see that gene selection is random and results in variation within a family. Specifically, students will model gene transmission from the mother and father cat, both heterozygous (carriers of the recessive gene) to see that some offspring will be orange (both homozygous dominant and heterozygous) and some will be cream (homozygous recessive).

Focus Question: How are traits, like fur color, passed from parents to young?

- Students will understand that 50% of the kitten's genes come from mom and 50% come from dad.
- Students will understand that gene selection is random and results in genetic variation within families.

Ambitious Science Teaching: SUPPORTING ON-GOING CHANGES IN STUDENT THINKING

This practice supports on-going changes in student thinking by (1) introducing ideas to reason with, (2) engaging with data or observations, and (3) using knowledge to revise models or explanations. For more, visit http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

PE 1-LS3-1: Make observations to construct an evidence-based account that young animals and plants are like, but not exactly like, their parents.

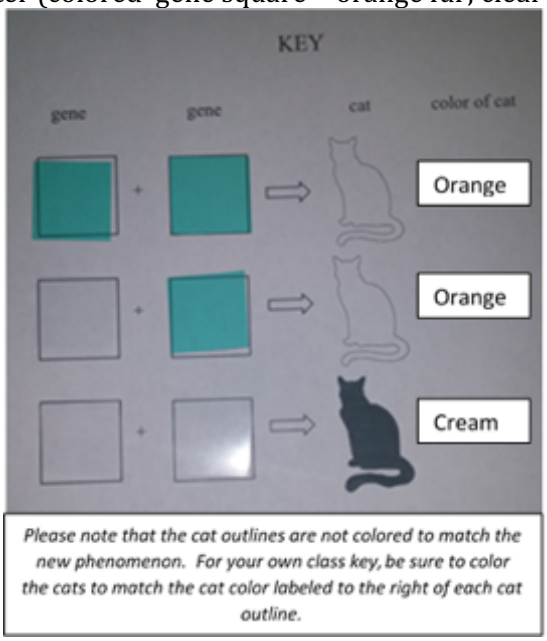
Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Constructing Explanations and Designing Solutions: Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-LS3-1)	Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (1-LS3-1)	Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. (1-LS3-1) .

Common Core Connections:
CCSS.ELA-LITERACY.RL.1.1: Ask and answer questions about key details in a text.
CCSS.ELA-LITERACY.RL.1.3: Describe characters, settings, and major events in a story, using key details.

MATERIALS

For the Class:

- Gene Squares Key - Poster (colored gene square = orange fur; clear gene square = cream fur)



Please note that the cat outlines are not colored to match the new phenomenon. For your own class key, be sure to color the cats to match the cat color labeled to the right of each cat outline.

******* Be sure to add an additional row to the above key to include a heterozygous orange cat with the gene squares in the reverse order. In other words, a colored gene square first and a clear gene square second will also result in an orange colored cat.***

Per student group:

- Gene squares
  - 4 Dense (orange) fur gene squares (dominant) 1 inch by 1 inch squares of colored transparency
  - 4 Dilute (cream) fur gene squares (recessive) 1 inch by 1 inch squares of clear transparency
- Envelope/bag
  - Label for each bag- mom and dad
- Recording sheet
- *Optional:* Gene Squares Key - table copy (colored gene square = orange fur; clear gene square = cream fur)

OPTIONAL: As a way of providing more opportunities for students to engage with the content, give each student 4 gene squares (two colored and two clear) that are affixed to popsicle sticks. When engaging in class discussions, readings, review, etc., encourage students to hold their gene squares and display the appropriate gene square combination when asked to make predictions or give information about individual cats.

PREPARATION


45 minutes

Materials preparation and lesson set-up takes approximately 30 minutes and can be done the day prior to the activity.

1. Cut gene squares (10 minutes)

2. Glue labels on bags (10 minutes)
3. Load Bags with gene squares - 4 clear squares and 4 colored squares per bag (10 minutes)
4. Create student "gene square sticks" (2 clear and 2 colored squares each on a Popsicle stick per student). *These can be used for several lessons.* (15 minutes)

PROCEDURE

Notes: Display family tree poster
Display fur color key
Decide if students will be working independently or with a partner

Day 1:

4. *Review*
   a. Fur color- Creamsicle has cream fur and his siblings have orange fur along with his mom and dad..

5. *Intro:*
   a. Today we are going to do an activity to show you how Creamsicle gets his cream fur from his parents. All cats get instructions for their fur color from their parents. Our activity today will show how these instructions are passed.
6. *Rules for activity*

b. For each kitten students will pull 1 gene from the mom bag and 1 gene from the dad bag.
c. Place the genes on the recording sheet
d. Students will do this 4 times representing how kittens from the same litter get genes from mom and dad, but may look different.
e. Have students glue or tape the genes on their recording sheet to refer back to on day two.

Teacher Decision Point

You can begin the reading for background information first or debrief the activity first.

Day 2 (or Day 3):

1. *Debrief Activity*
   a. These squares represent genes
   b. Define "genes"

      Genes- ***your body's directions/instructions for traits. Genes come from birth mom and dad. Genes come in pairs (1 from mom and 1 from dad)***

   c. *These directions/instructions mean something. On _____ you picked 1 gene from the mom and 1 gene from the dad for each kitten. Now we are going to look at what those genes mean for the color of the kittens' fur and all the different colors of kittens we got.*

2. *Show Key*
   a. Here is what those instructions mean.
      Color + Color = orange cat
      Color + Clear = orange cat
      Clear + Color = orange cat
      Clear + Clear = cream cat

3. *Analyze their kittens from day 1*
   a. Have students use the key to color and write out the color of each of their 4 kittens.
   b. Back-Pocket-Questions (on the left)

Back-Pocket Questions

- What do you notice there has to be to get an orange cat?
- What genes make an orange cat?
- Is more common to get an orange cat or a cream cat? WHY?
- How can you get a cream cat from 2 orange cats?
- What genes make a cream cat?

Teacher Decision Point

Decide how to best structure this reading task based on student needs.

Day 3 (or Day 2 - See teacher decision point)

1. *Reading about genes and traits*
   a. Review key observations from the hands-on experiment portion of this lesson regarding how gene combinations can make kittens look different from their parents.
   b. Students can look at their recording sheets. Students may have found results like: *all of the kittens have orange fur, some of the*

kittens have orange fur and some have cream fur, more of the kittens have orange fur than cream fur.

c. Have students read the reading in this lesson guide (and/or similar short readings from other sources).
d. Have students add what they learn from the reading to the summary table, particularly about genes and traits. Introduce 2-3 word wall cards after reading (particularly gene and trait). Also, think about how this information about genes and traits might connect to how the kitten had cream fur when both the parents had orange fur.

Public Record

Creamsicle Family Tree with Gene Post-its

Day 4:

1. *Connections to the phenomena (whole class)*
    a. Use information from the gene simulation activity and readings to complete any missing information from the 'observations' and 'learning' columns. Have students think about how this could help explain why Creamsicle has cream fur even though his parents have orange fur. *How might Creamsicle's genes affect his fur color? How could his parents pass genes for cream fur if they have orange fur?*

Activity	***What did we observe?***	***What did we learn?***	***How does this help us explain Creamsicle's cream fur?***
Gene Simulation (Sketch activity or paste photo taken during activity here)	Genes are instructions for making traits. Inherited Traits: traits that are passed from parents to their young	Genes come in pairs Half of genes come from mom Half of genes come from dad	Creamsicle's cream fur is an inherited trait. Creamsicles 'genes have instructions to make his fur cream. Creamsicle got half of his genes from his mom and half of his genes from his dad.

Examining Student Work and Conversations

1. Can students explain that kittens get 50% of their genes from mom and 50% from dad?
2. Do they understand that an orange cat can still carry a cream fur gene? They might refer to this as hidden or weak.

PLANNING NEXT STEPS

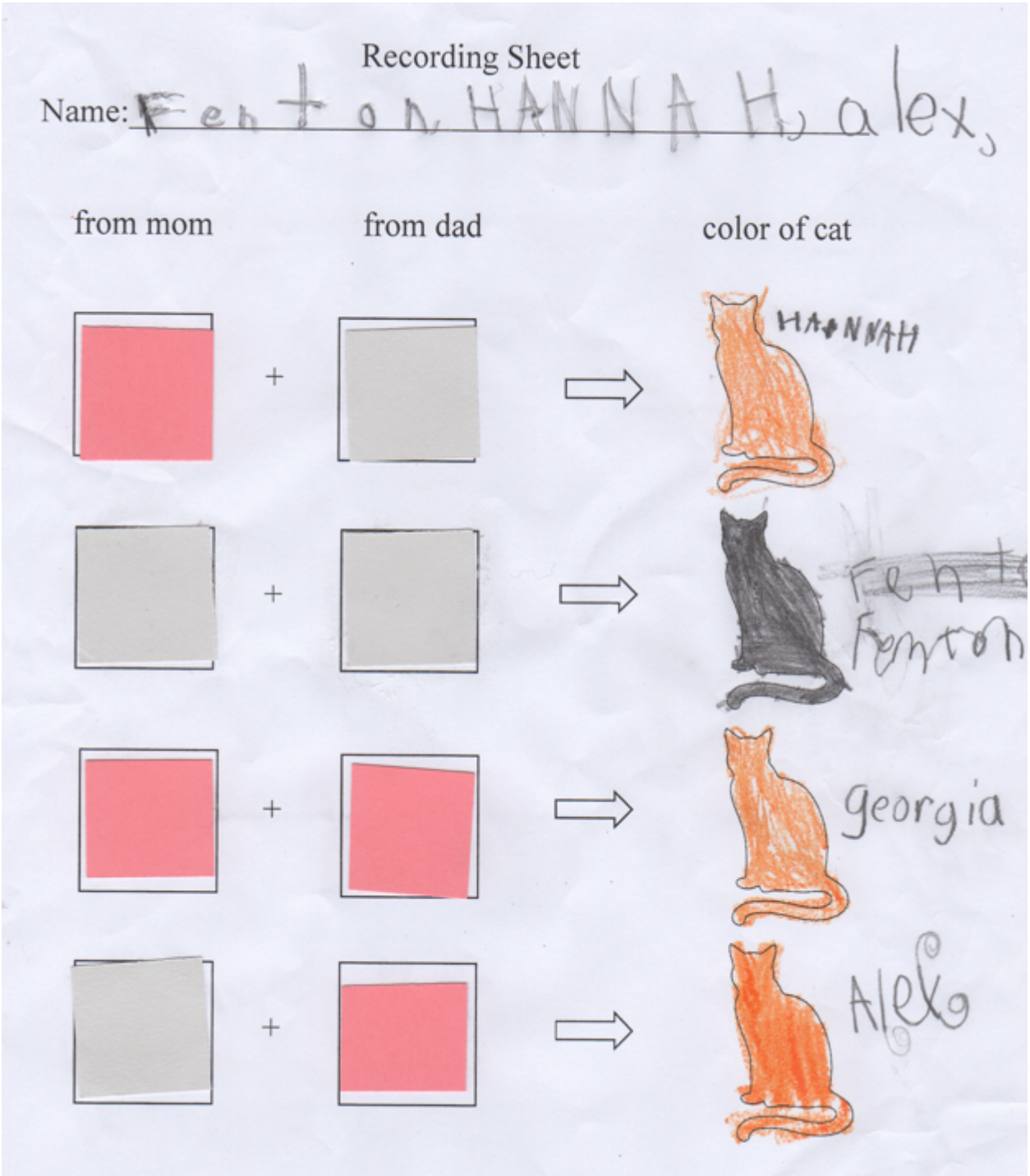
Using ideas and questions you have heard from students during class decide what lesson(s) should come next. What questions do students have that could anchor future lessons? What lessons might need to be added to help students build their understanding.

Gene Simulation Bag Labels

Directions: Make enough copies for each student group to have 1 mother label and 1 father label. Cut out the labels and affix them to the outside of the paper bags before the lesson.

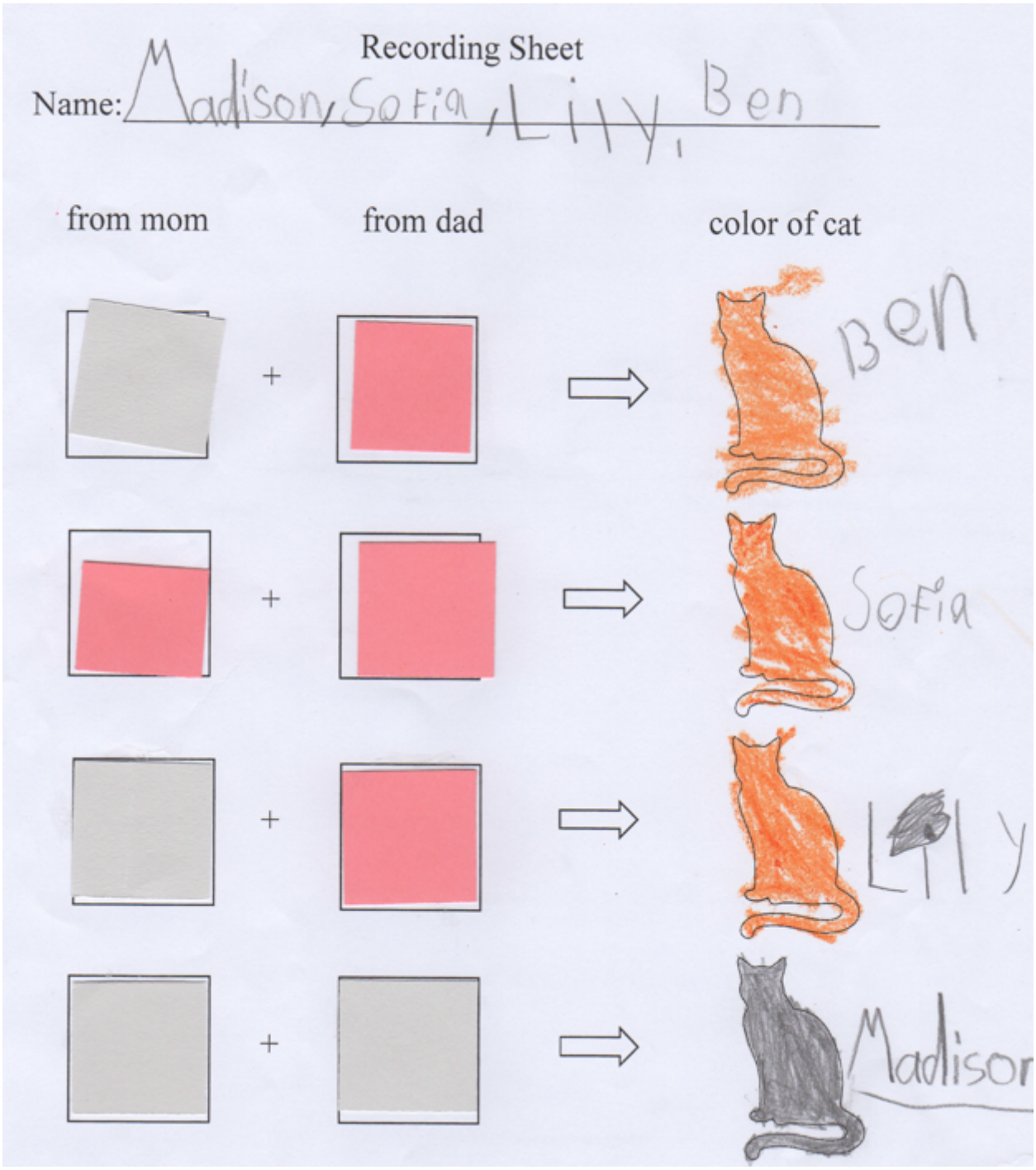
	
Mother Cinnamon	**Father** Orange Star

Here are 4 examples of 1st grade students' recording sheets. This student work was completed in groups by a class using an alternative color phenomenon. The teachers also used clear laminating sheets instead of transparencies. Both options allow students to see that a gene (square) may be present but not visible.



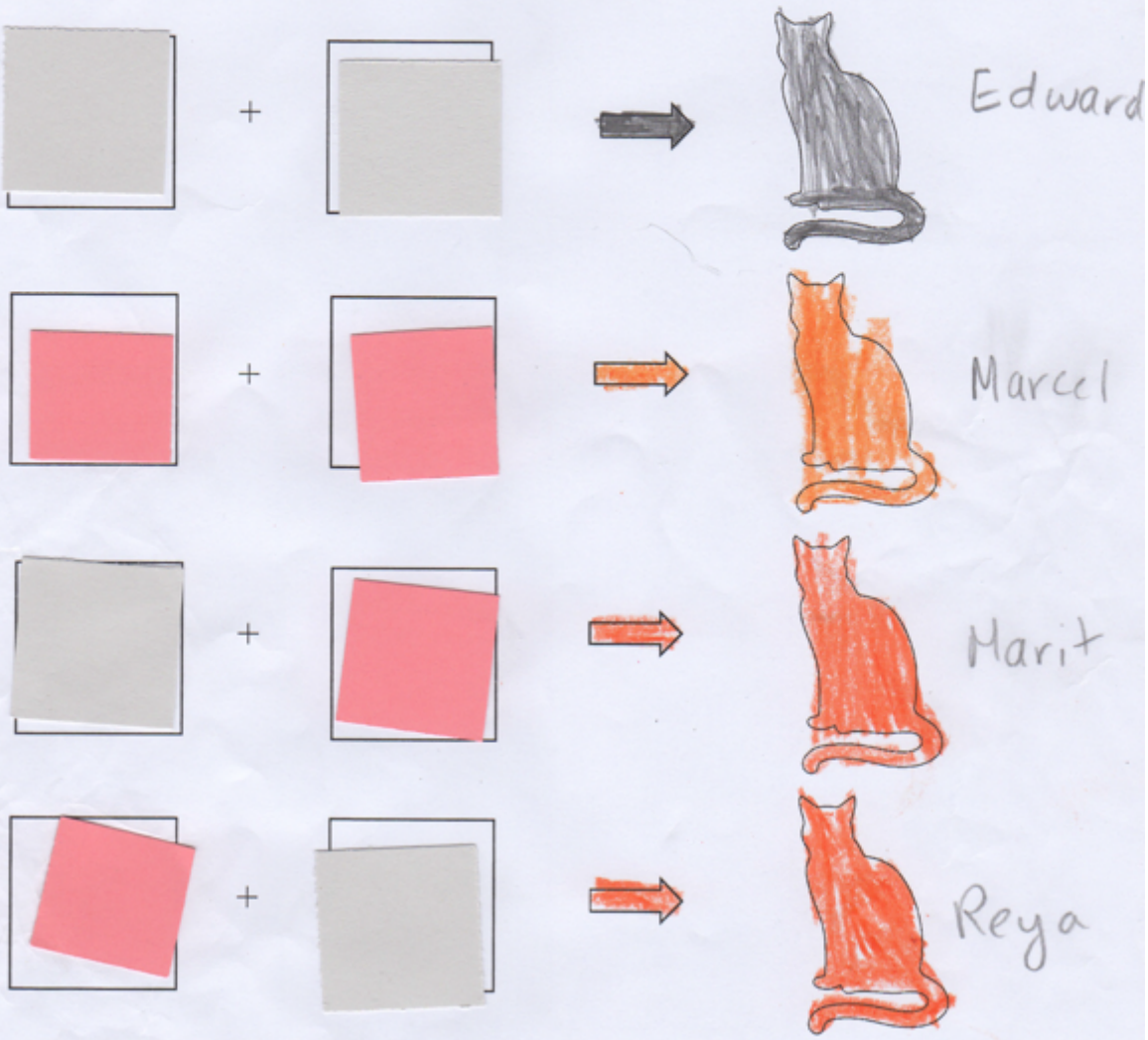
Recording Sheet

Name: Madison, Sofia, Lily, Ben



Recording Sheet

Name: Marcel + Reya + Marit + Edward = Team



Recording Sheet

Name: Juliana, Mr. G. Luke. Aili.

	from mom		from dad		color of cat
J		+		→	
M G.		+		→	
L		+		→	
A		+		→	

TEACHER REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

Keep a record of these reflections for your professional portfolio.

1. TASK, TALK, & TOOLS

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of the gene simulation helped students to/with…*
- *The task about _____ relates to students' and/or their families' lives because…*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked to each other during (name particular parts of lesson) which allowed students to…*
- *During turn-and-talks, I observed ____ which makes me wonder if/how…*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

- *The back-pocket questions allowed students to…*

Overall, reflecting on task, talk, and tools together:

- *Talk, task, and tools supported students to share their thinking because…*
- *Overall, this combination of talk, task, and tools, allowed most/all students to…*

_____

_____

_____

EQUITY. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific issue of equity:

- *Developing relationships and forming an inclusive, trusting community*
- *Scaffolding for full participation in the culture and language of science*
- *Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs*
- *Addressing power dynamics (how a person is seem and responded to by others) to disrupt stereotypes and privilege*

_____

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_____

_____

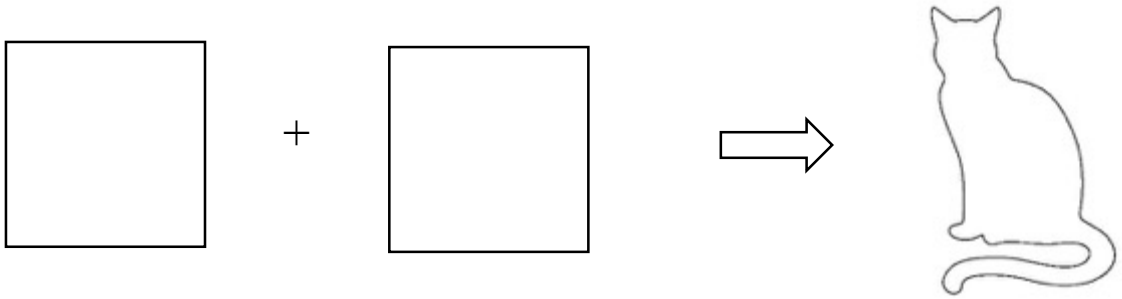
_____

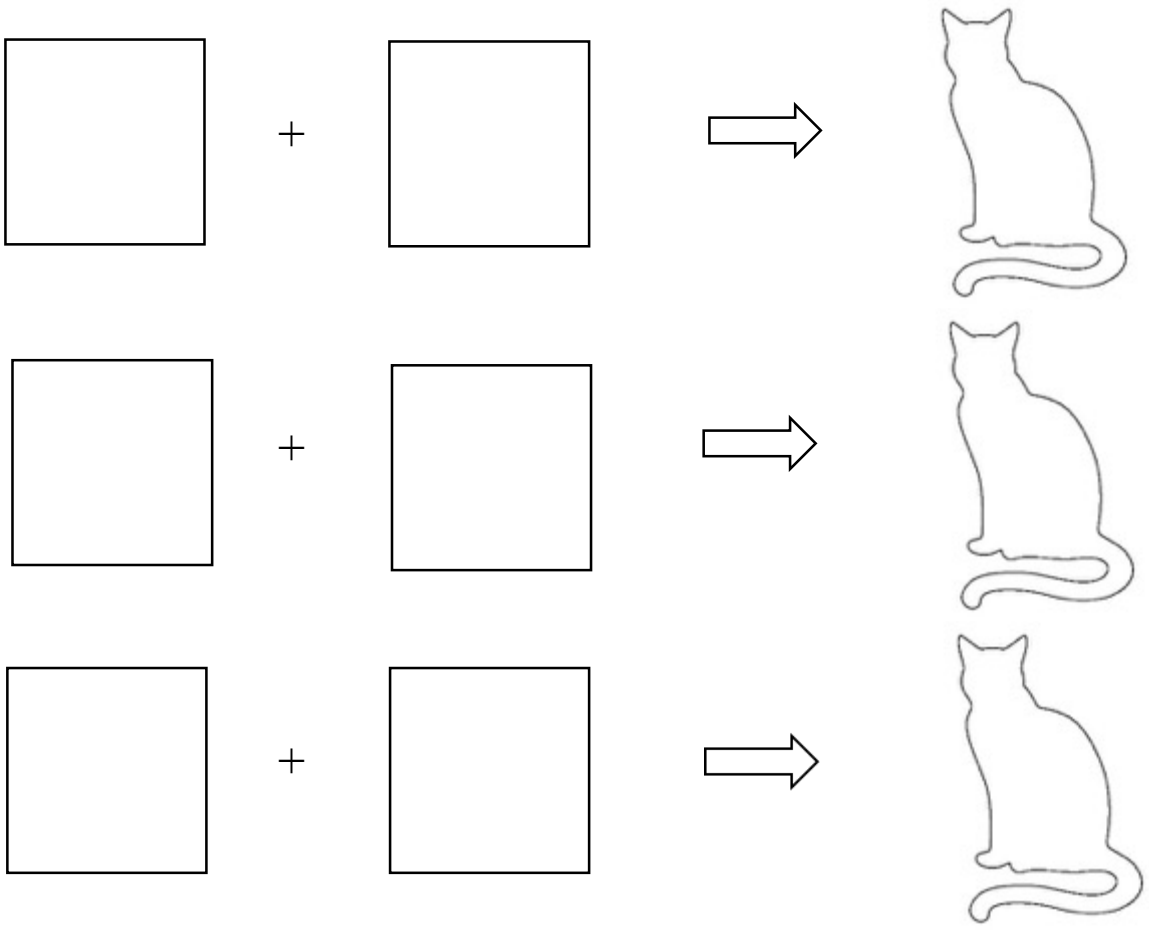
Gene Simulation Data Sheet

Name:_____

_____

From mom	From dad	Color of cat





From Cat to Kitten: How Traits are Passed

Cinnamon was Vivian's cat. Cinnamon had 4 kittens. Vivian was so excited to see the kittens! Vivian saw all the kittens had fur. Cinnamon had orange fur. Three of the kittens had orange fur. One of the kittens had cream fur. Not all the kittens looked the same. "Why are they different?" Vivian asked her mom. Vivian's mom told her that the kitten's differences are called **traits.** Kittens have many different traits.

Fur color is a trait. Eye

Inside each kitten's body are directions for traits. These directions are called **genes.** **Genes tell the kitten's body how to work and grow.**

You follow directions to build a

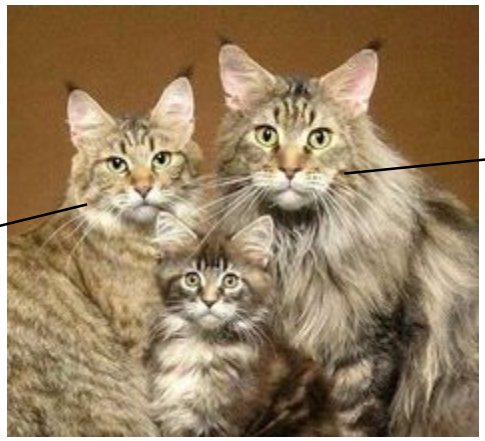
Text sources: *Unusual Traits: Tongue Rolling, Special Taste Sensors, and More by Lightning Bolt Books, and http://www.harmonydc.org/Curriculum/pdf/1sample.pdf*
Modified by: *C. LaMotte*

Vivian's mom told her that young animals get the genes for traits from their parents. Traits that are passed from the parents to their young are called **inherited traits**. "Kittens have fur because their parents have fur," said Vivian's mom. "They also have four legs, two ears, two eyes, and a nose. These traits were passed down from their parents. Young animals inherit these traits from their parents."

"What other traits can be inherited from parents?" Vivian wanted to know. "Kittens also get the way their body is built from their parents. If parents have big ears, then the kittens may have also have a big ears. If a parent is a kind cat, it may also pass that trait on to its young. Sometimes the way an animal behaves can also be passed down from parent to child."

"Wow," said Vivian. "I didn't know all of these traits came from the parent. But not all the kittens look just like Cinnamon. Why is that?" Vivian wanted to know.

"Genes come in pairs. One of each pair came from mom cat. The other pair came from dad cat" explained Vivian's mom. "The kitten's genes make them different from other kittens and their parents. Young animals are very much like their parents, but they are not exactly the same."



Text sources: *Unusual Traits: Tongue Rolling, Special Taste Sensors, and More by Lightning Bolt Books, and http://www.harmonydc.org/Curriculum/pdf/1sample.pdf*
Modified by: *C. LaMotte*

KEY

Gene	Gene	Cat	Color of Cat
☐ +	☐ ⇨		Orange
☐ +	☐ ⇨		Orange
☐ +	☐ ⇨		Cream

Lesson 6: Gene Theater

OBJECTIVES & OVERVIEW

This lesson gives students the opportunity to act out what they have learned about how traits are passed from parent to offspring within a family. Students will be assigned a role in the family and then physically model the transmission of genes.

Focus Question: What gene combinations must Creamsicle's grandparents have?

- Students physically model the transmission of genes in a family.
- Students apply their knowledge of genes and traits to determine the gene combination in the members of Creamsicle's family.

Ambitious Science Teaching: SUPPORTING ON-GOING CHANGES IN STUDENT THINKING

This practice supports on-going changes in student thinking by (1) engaging with observations, (2) collecting data, and (3) applying information to a new situation. For more information visit http://AmbitiousScienceTeaching.org.

NEXT GENERATION SCIENCE STANDARDS

PE 1-LS3-1 Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Constructing Explanations and Designing Solutions • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-LS3-1)	• Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (1-LS3-1)	• Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. (1-LS3-1)

PREPARATION

45 Minutes

Materials preparation and lesson set-up takes approximately 45 minutes and can be done the day prior to the activity.

1. Prepare a bag for each member of Creamcle's family by writing the name of the cat (and its position in the family) and/or gluing a picture of the cat (15 minutes).

2. Cut gene squares (10 minutes). *Note: You can use the gene squares from the previous lesson if they are still available.*

3. Create paper headbands with the name of each cat and their position in the family. You can also include a picture. (20 minutes). You will need to create 10 headbands if making one class set.

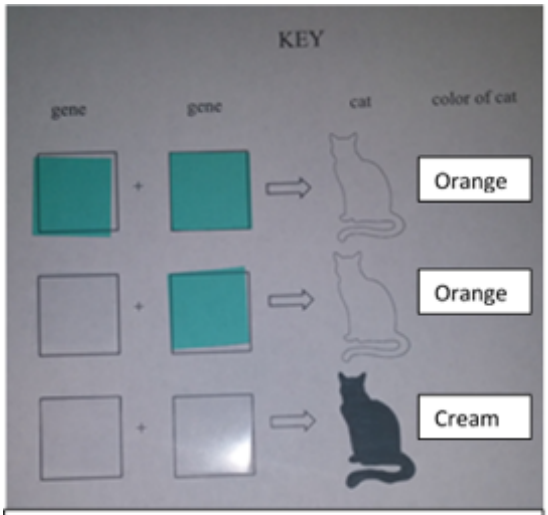
Teacher Decision Point

Decide if students will act out gene transmission one group at a time or several groups at a time.

MATERIALS

For the Class:

- Creamsicle's family tree (*From Lesson 2*)
- Bags to hold "genes" for each member of Creamsicle's family. *(NOTE: you can have one set and repeat the activity until all students have participated or you can have several sets to allow students to complete the activity simultaneously)*
- Label for each bag with the name (and picture) of each cat in the family
- Gene squares
    - 4 sets per grandparent:
        - 16 Dense (orange) fur gene squares (dominant) 1 inch by 1 inch squares of colored transparency
        - 16 Dilute (cream) fur gene squares (recessive) 1 inch by 1 inch squares of clear transparency
- 10 Paper Headbands labeled with a name (and picture) of each cat in the family. *Note: If completing the gene theater with multiple groups at a time, more headbands will need to be available.*
- Gene Squares Key - Poster (colored gene square = orange fur; clear gene square = cream fur)



Please note that the cat outlines are not colored to match the new phenomenon. For your own class key, be sure to color the cats to match the cat color labeled to the right of each cat outline.

******* Be sure to add an additional row to the key on the left to include a heterozygous orange cat with the gene squares in the reverse order. In other words, a colored gene square first and a clear gene square second will also result in an orange colored cat.***

- Post-it Notes: 2 sets of colors matching the gene squares (colored post-it = orange fur; white post-it = cream fur)
- *Optional:* Gene Squares Key - table copy (colored gene square = orange fur; clear gene square = cream fur)

PROCEDURE

Present Visuals

Show Creamisicle's Family Tree Poster with fold-up pictures.

1. Activate prior knowledge and experiences (whole class)

a. Introduce this lesson by revisiting what students learned in lesson about genes and how genes are instructions for traits, such as fur color. Point to the summary table to highlight the key ideas. Point to the Family Tree poster and tell students that today they will be modeling how genes passed through each generation of Creamsicle's family.

Focus Question: What gene combinations must Creamsicle's grandparents have?

Turn-and-Talk

What gene combination did we determine Creamsicle's parents had? How did we know? What gene combination might the grandparents have?

b. Have students turn-and-talk about what gene combination both of Creamsicle's parents had. Ask them to make predictions about what gene combination each of the grandparents must have. *OPTION: Have students write and draw about their experiences first before partner talk.*
   - **Listen in as students talk in partners for ideas of observable and unobservable traits.**

Teacher Decision Point

Decide if students will act out gene transmission one group at a time or several groups at a time.

Back-Pocket Questions

2. **Getting the Activity Started (whole class)**

   a. Show the materials: Gene bags, headbands, and gene squares. Explain to students that each member of Creamsicle's family has many pairs of genes that are instructions for their fur color. Today, students will act out how genes were passed in Creamsicle's family. Each student will get to play the role of one of the cats in the family. Quickly demonstrate for students how to put on their headband and "choose" gene squares.

   b. Choose 10 students to act as the members in creamsicles family. Have them put on their cat name headband. Next, ask the 4 "grandparents" to each pull out one gene square at random. Once the gene squares are revealed, depending on the gene combination, choose one cat in the next generation with the corresponding gene combination. Ask the student with that cat headband to come forward and collect the genes. (If an offspring without heterozygous gene combination is selected in generation 2, tell students that that would be a sibling of the parent and choose again.) For generation 3, the teacher will need to add more copies of each gene square to the parents in generation 2. Ask the parent to each pull out one gene square at random. Once the gene squares are revealed, depending on the gene combination, choose one cat in the next generation with the corresponding gene combination. Ask the student with that cat headband to come forward and collect the genes. Repeat until all of the members of Creamsicle's family have received their gene squares.

3. **Making observations and uncovering patterns using questions (small groups)**
   a. As students act out the passing of genes from parents to offspring, record on the classroom family tree the gene combination of each offspring (using post-its). *Note: do not reveal the grandparent's gene combination.*
   b. Ask students to make observations about how the genes are being passed.

   Focus Question: What is the job of each cat feature and how do these features help cats survive?

   **You can have each group talk about all 8 features or assign different partners 1 word and have them share out with the class.

   - How many genes for fur color are passed from each parent?
   - How are the genes that are passed chosen?

Note: Be sure to emphasize that each individual would have many copies of each gene but that for the sake of modeling, we have only included a few. As well, that the genes wouldn't "run out" in a real cat.

Public Record

Creamsicle Family Tree with Gene Post-its

4. **Publicly sharing observations (whole class)**
   a. Have table groups recap the activity and make a prediction about what gene combination each grandparent has.
   b. Share-out what was observed and learned in this activity and add it to the "observation" and "learn" columns of the summary cart. Students may have noticed things like: "one fur color gene comes from mom and one comes from dad; genes are chosen randomly; siblings can have different gene combinations."
   c. Ask students to share-out their predictions. Lift the pictures of the grandparents to reveal the gene combination below.

Note:
• Pearl (cream fur - grandmother) = cream/cream
• Flame (orange fur - grandfather) = orange/ ? (Flame could have either orange/orange, or orange/cream
• Peaches (orange fur - grandmother) = orange/cream
• Pumpkin (orange fur - grandfather) = orange / ? (Pumpkin could have either orange/orange, or orange/cream)

Activity	***What did we observe***	***What did we learn?***	***How does it help us explain Creamsicle's cream fur?***
Gene Theater (Sketch activity or paste photo taken during activity here)	Parents pass down half of their genes to their offspring	When genes are passed down, the selected genes are "chosen" at random.	Creamsicle got one gene for fur color from his mother and one gene for fur color from his father. The genes were chosen at random and resulted in Creamsicle's cream colored fur.

EXAMINING STUDENT WORK

Use student discussions and summary chart to track students' understanding and reasoning about why Creamsicle has cream fur.

PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class and from their summary chart entry, decide what lesson(s) should come next. Do students need an additional experience or opportunity to demonstrate an NGSS performance expectation? Do students have enough understanding to move into the final model?

TEACHER REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

Keep a record of these reflections for your professional portfolio.

1. TASK, TALK, & TOOLS

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of the gene simulation helped students to/with…*
- *The task about _____ relates to students' and/or their families' lives because…*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked to each other during (name particular parts of lesson) which allowed students to…*
- *During turn-and-talks, I observed ____ which makes me wonder if/how…*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

- *The back-pocket questions allowed students to…*

Overall, reflecting on task, talk, and tools together:

- *Talk, task, and tools supported students to share their thinking because…*
- *Overall, this combination of talk, task, and tools, allowed most/all students to…*

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EQUITY. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific issue of equity:

- *Developing relationships and forming an inclusive, trusting community*
- *Scaffolding for full participation in the culture and language of science*
- *Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs*
- *Addressing power dynamics (how a person is seem and responded to by others) to disrupt stereotypes and privilege*

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Lesson 7: Track the Traits

OBJECTIVES & OVERVIEW

This lesson gives students the opportunity to apply what they have learned about traits to themselves. Students will identify a variety of gene controlled human traits, determine which form of the trait they have, and then collect data on the frequency of the traits in their classroom.

Focus Question: What are some examples of human traits controlled by genes?

- Students make observations and collect data about different human traits.
- Students apply their knowledge of genes and traits in cats to themselves.

Ambitious Science Teaching: SUPPORTING ON-GOING CHANGES IN STUDENT THINKING

This practice supports on-going changes in student thinking by (1) engaging with observations, (2) collecting data, and (3) applying information to a new situation. For more information visit http://AmbitiousScienceTeaching.org.

NEXT GENERATION SCIENCE STANDARDS

PE 1-LS3-1 Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents. [Clarification Statement: Examples of patterns could include features plants or animals share. Examples of observations could include leaves from the same kind of plant are the same shape but can differ in size; and, a particular breed of dog looks like its parents but is not exactly the same.] [*Assessment Boundary: Assessment does not include inheritance or animals that undergo metamorphosis or hybrids.*]

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Constructing Explanations and Designing Solutions • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-LS3-1)	• Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (1-LS3-1)	• Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. (1-LS3-1)

MP.4 Model with mathematics.
MP.5 Use appropriate tools strategically. (*1-LS3-1*)

MATERIALS

For the Class:

- Classroom trait tally sheet
- Graph paper to make histogram of trait frequency
- Reading "Our Traits"
- Summary Chart

Per Individual:

- Track the Traits Student Data Sheet
- PTC paper
- Graph Paper (optional)
- Colored Pencils (optional)

PROCEDURE – Part 1

Turn-and-Talk

What are some examples of human traits that are visible? What are some examples of human traits that are not visible?

1. **Activate prior knowledge and experiences (whole class)**

   a. Introduce this lesson by revisiting what students learned about traits, including examples of common cat traits. Point to the Cat Diagram and tell students that today they will be observing and collecting data on a variety of human traits controlled by genes.
   Focus Question: What are some examples of human traits that are controlled by genes and how do these traits get passed?

   b. Have students turn-and-talk about their experiences and prior observations about human traits. What are some visible human traits? What are some traits that are not visible? *OPTION: Have students write and draw about their experiences first before partner talk.*
      - **Listen in as students talk in partners for ideas of observable and unobservable traits.**

2. **Getting the Activity Started (whole class)**

   a. Show the materials: PTC paper and data sheet. Explain to students that PTC paper is used to determine if people can taste the chemical PTC. Quickly demonstrate for students how to determine which version of the trait they have and how to record the information on their data sheet.

3. **Making observations and uncovering patterns using questions (small groups)**

   a. Circulate as students collect data about themselves and their table mates. Redirect and help students with data collection as necessary.
   b. As students make observations about traits ask students questions to relate back to genes.

Back Pocket Questions

Back-Pocket Questions

- *What is the role of genes in this trait?*
- Using what you know about how traits are passed in cats, how did you get this trait?
- *Why would you have differences in this trait compared to your birth parents and/or siblings?*

Public Record

Track the Traits Data Chart

4. **Publicly sharing observations (whole class)**
   a. Have table groups share their data while the teacher tracks the trait frequency on a class data sheet under the document camera.
   b. Share-out observations about what happened in this activity and add it to the "observation" column of the summary cart. Students may have noticed things like: *"we all have similar traits; we are all like each other but not exactly alike; we are more alike than different; ____ is more common than ___"*

      OPTION: Teachers can enter data in a graph format so students can better visualize frequencies of different traits.

Part 2. Reading about Traits & Summary Table

Teacher Decision Point

Reading Scaffolding
Decide how to best structure this reading task based on student needs.

Public Record

Summary Chart Row

1. Reading about how traits are passed in humans

a. Review key observations from part 1 regarding human traits.
b. Have the students read the lesson in this lesson guide (and/or other similar short readings).
c. Have students add what they learn from the reading to the summary table, particularly about how genes come in two forms and sometimes one form of the gene is present but not expressed.

2. Connections to the Phenomena (whole class)

a. Use any information from the activity or reading to complete any missing information from the 'observations' and 'learning' columns. Have students think about how this might inform us about Creamsicle's cream fur.

Activity	*What did we observe*	*What did we learn?*	*How does it help us explain Creamsicle's cream fur?*
Track the Traits (Sketch activity or paste photo taken during activity here)	Students have one of two versions of a trait.	Genes come in two forms. Sometimes, one form is present but not seen in the trait.	Creamsicle's siblings each have at least one gene for orange fur. Both of Creamsicle's genes must be for cream fur.

EXAMINING STUDENT WORK

Use student discussions and summary chart to track students' understanding and reasoning about why Creamsicle has cream fur.

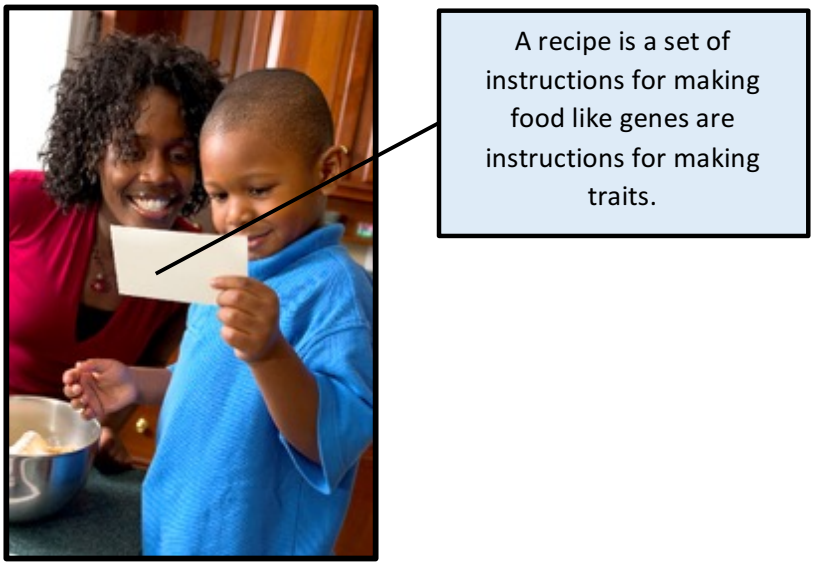
PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class and from their summary chart entry, decide what lesson(s) should come next. Do students need an additional experience or opportunity to demonstrate an NGSS performance expectation? Do students have enough understanding to move into the final model?

Our Traits

Vivian learned about traits and genes when her cat Cinnamon had four kittens. Vivian began to wonder about herself. "Do people have traits too?" Vivian asked her mom. Her mother told her yes, people have many traits.

Just like with kittens, the instructions for these traits in humans are called **genes.** Genes tell our body how to work and grow.



Text sources: *Unusual Traits: Tongue Rolling, Special Taste Sensors, and More by Lightning Bolt Books*
Written by: *C. LaMotte*

"Where did my genes come from?" wondered Vivian. Her mother explained that she got her genes from her birth mother and father. "You are related to your birth parents. As your adoptive parents, your father and I brought you into our family and became your parents. There are many different kinds of families" explained her mother.

Families come in many varieties. Genes come from birth parents, but families are made of love.

Her mother continued to explain, "Genes come in pairs. One of each pair came from your birth mom. The other came from your birth dad. The combination of genes that you get is special to only you. Your genes are unique instructions that make you different from other people." Vivian smiled. She realized that her genes work similarly to the genes in kittens.

Our genes make us different from other people.

People have more in common with one another that they do with other animals such as cats.

Text sources: *Unusual Traits: Tongue Rolling, Special Taste Sensors, and More by Lightning Bolt Books*
Written by: *C. LaMotte*

Vivian wanted to know more about traits in people. "Our genes are the instructions for our traits. Some traits, such as freckles, are easy to see. Other traits, such as whether or not you like broccoli, are not visible" explained her mother.

Other visible traits controlled by genes include eye color and face shape.

Your personality is an example of a hidden trait controlled by genes.

"What do our genes have to do with broccoli," asked Vivian. "A chemical called PTC is in broccoli. Your genes control whether you can taste PTC. The gene for tasting PTC comes in two forms. One form makes PTC taste bitter. The other form doesn't react to PTC," said her mother.

If you have two copies of the form that makes PTC bitter, you can taste it.

If you have two copies of the form that doesn't react to PTC, you do not taste it.

"But what happens if you get one copy for tasting PTC from one parent and one copy for not tasting PTC from the other parent?" asked Vivian. "That is such a great question! If someone gets one of each form, the PTC tasting form takes control. So the person would taste PTC," explained her mother.

The non-tasting form is there, but it is not expressed. This boy tastes PTC and doesn't like broccoli.

The people with the gene for PTC can learn to like broccoli.

"So this is like Silver and his siblings," said Vivian. She continued, "The gene for orange fur in kittens is similar to the gene for tasting PTC in people. Silver' siblings must have at least one form of the gene that gives instructions for orange fur. The cream fur gene might be in there, but just not expressed."

Each of these kittens has at least one gene for orange fur. The other gene may be for orange fur or grey fur.

Vivian's mother smiled. "Yes. That is right." Then she asked Vivian, "Do you have an idea how Silver got his cream fur?" Vivian thought for a minute and suddenly her face lit up. "Yes, I do!"

How did Creamsicle get his cream fur?

"Silver has cream fur because he has two copies of the form that give instructions for cream fur. And he must have gotten one copy for the cream fur gene from his mom and one copy from his dad!"

Track the Traits - Student Data Sheet A

Name: _____

Directions: Circle each trait that you have.

Trait Version 1	Trait Version 2
 Can roll tongue	 Can't roll tongue
 Widow's Peak	 No Widow's Peak
 Straight thumb	 Bent thumb
 Can taste PTC paper	 Can't taste PTC paper

Track the Traits - Class Data Sheet

Directions: Put a tally mark next to each trait you have. Once every student has marked their traits, count how many of each trait you have in class.

Traits	Tally Marks
Can roll tongue	
Can't roll tongue	
Widow's peak	
No widow's peak	
Straight thumb	
Bent thumb	
Can taste PTC paper	
Can't taste PTC paper	

TEACHER REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

1. **TASK, TALK, & TOOLS**

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of observing traits and tracking their frequency…*
- *The task about … relates to the students and/or their families because…*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

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2. **EQUITY**. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific category of equity:

- Developing relationships and forming an inclusive, trusting community
- Scaffolding for full participation in the culture and language of science
- Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs
- Addressing power dynamics (how a person is seen and responded to by others) to disrupt stereotypes and privilege

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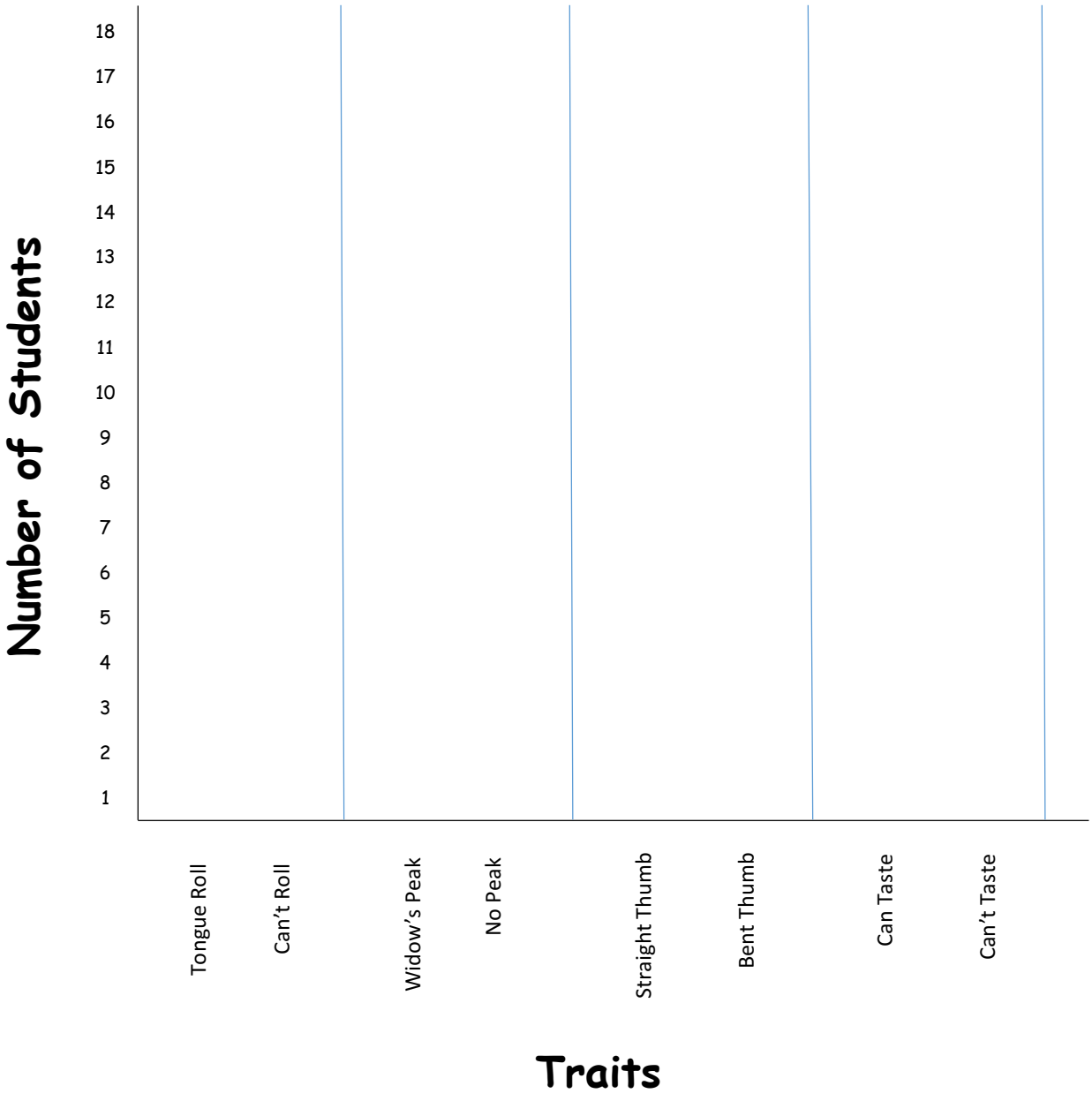
Title: Classroom Trait Data



Lesson 8: Creamsicle Model

OBJECTIVES & OVERVIEW

Students have been revising their thinking about the unit phenomenon over time in light of new experiences, observations, and sense making talk that they have had throughout the unit activities. In this lesson, students will pull together what they have learned in this unit and identify how their thinking has changed by revising their models and supporting changes with evidence.

Focus Question: Why does Creamsicle have cream fur? What evidence do we have?

- Students review and revise their models in light of new learning from unit activities to explain the phenomenon.
- Students write and draw a short evidence-based explanation for the phenomenon.

Ambitious Science Teaching Framework: PRESSING FOR EVIDENCE-BASED EXPLANATIONS

This practice happens is the last third of the unit, but parts can be introduced at other times when students talk about evidence. This requires that several tools be available to students: 1.) their original models, 2.) an explanation checklist, 3.) the summary table, and 4.) a scaffolded guide to help students create, in writing and drawing, their final model. If you would like more information about these practices please visit: http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

1-LS3-1 **Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.** [Clarification Statement: Examples of patterns could include features plants or animals share. Examples of observations could include leaves from the same kind of plant are the same shape but differ in size; and, a particular breed of dog looks like its parents but not exactly the same.] [*Assessment boundary: Assessment does not include inheritance of animals that undergo metamorphosis or hybrids.*]

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Developing & Using Models: **Develop a model to describe phenomena. **Constructing Explanations:** **Identify the evidence that supports particular points in an explanation. ***This SEP is not part of the PE but was added to this lesson as part of the AST framework.*	Young animals are very much, but not exactly like, their parents. Plants also are very much, but not exactly, like their parents. (1-LS3-1)	Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. (1-LS3-1)

MATERIALS

For the class:
- Summary Table
- Chart Paper
- Markers

For each student:
- 1 blank Creamsicle Model
- Original model scaffolds (completed in pairs in lesson 1)
- Colored pens or pencils
- Previous student work from the unit

Procedure: Part 1. Revising Models with Evidence

Present Visuals

Show picture of Creamsicle' family tree.

Turn-and-Talk

What ideas do we need to include in an explanation of the phenomenon?

Public Record

Explanation checklist

1. GENERATE EXPLANATION CHECKLIST (WHOLE GROUP) - 10 mins

a. Remind students of the unit phenomenon using Creamsicle' family tree poster. **Why does Creamsicle have cream fur? What evidence do we have?**
b. Ask students to think about what they have learned in this unit (encourage them to look at the summary table) and identify: What are the key pieces that we have to know in order to explain the phenomenon. Give private think time. Have students turn-and-talk.
c. Share out some ideas and generate an explanation checklist on a chart paper with markers. This list might have items on it such as:

Explanation checklist:
We should…
- Use our observations about how genes are passed from parent to offspring
- Include knowledge of genes and traits
- Explain how traits can be present but hidden

2. STUDENTS UPDATE EXPLANATORY MODELS (Individual) - 25 min

a. Leave the explanation checklist on the board for student reference. Tell students they will have a chance to show all the new ideas they have about why Creamsicle has cream fur by completing a final model. They have acquired these

new ideas because they have had so many experiences in this unit (point to the summary table).

b. Show students the final model and explain what you expect to see in each part of it. Also, remind students that both students in the pair should be talking, drawing, and writing on the sheet.
c. Read aloud the scenario.
d. OPTIONAL: Select three areas in the classroom to represent the three ideas on the model. Ask students to go stand in the person's area they agree with. Students can talk in the groups about their thinking. Each group can share out their thinking to the class before groups begin working on the model.
e. Give students time to work in pairs to complete the model. Redirect students as needed to the explanation checklist, the summary table, or their prior work to help them make progress on their models.

As students work in pairs, prompt reasoning about gaps and contradictions in their models. Back-pocket questions (to the left) could help you do this.

Back-Pocket Questions

As students work in pairs, prompt reasoning about gaps and contradictions in their models. These prompts or questions could help you do this:

- *"Can you tell me what role [Insert idea or concept] has in your explanation?"*
- *"How does this part about _____ fit with the rest of the model?"*
- *"How have you included this idea about _____ from the explanation checklist?"*
- *"I see you have drawn and labeled _____. How do you know it works like that? Have we done something in class on the summary table?"*

3. PREPARE STUDENTS TO USE EVIDENCE

a. Have a pair share one claim they have made on their model so far. It should be a claim that we have evidence for so far from an activity or reading from the unit.
b. Ask the class: What evidence do we have of this idea? Where can we look to remember what evidence we have?
c. Demonstrate how to write evidence on a sticky note and put it on the model next to the claim.
d. Give students 10 minutes to identify 1 claim on their model and write sticky notes about evidence. Each student in the pair should write one sticky note and share their evidence with their partner.
e. As students work, circulate and look at how students are selecting evidence. If they are stuck, refer them to the summary table or their activity worksheets. If students only name the activity, put some sentence stems on the board to help get more about why this activity provided us with evidence for a certain idea or claim.

PART 2. Comparing Models & Adding Evidence

Talk Norms

Remind students about talk norms

1. PUBLIC COMPARISON OF MODELS (whole group) - 20 mins

a. *Physically orient students toward each other.* Have students bring their model sheets to the gathering area and sit so

students can see and hear each other easily and see the screen when students share work under the document camera.

b. *Set the purpose of today's discussion:* Say something like: *We are coming together to see ways to represent ideas in models and how we use evidence to support our ideas. Give each other feedback by agreeing or disagreeing and saying why you think the evidence they picked supports their idea or if you think another piece of evidence from our summary table would be stronger. After the discussion you will have time to add more evidence or to clarify your ideas on your models.*
c. *Allow students to use talk norms and lead and manage the talk:* Remind students of talk norms and encourage them to call on each other and not look to the teacher.
d. Choose one pair to start the conversation and have them share one claim and the evidence they selected to support it. Encourage students to agree or disagree, in either case saying what evidence they used or would use and how it supports their idea. Students should be sharing work under the document cameras as they have a discussion. Peers could suggest changes to either their ideas or the evidence they selected.

Whole-class discussion

Collaboratively revise a model based on evidence

NGSS Note: In Appendix F: Science and Engineering Practices, one performance of developing and using models for grades K-2 students is to develop a model based on evidence and then compare models to identify common features and differences. Students are mostly doing this in pairs for this lesson but this whole group discussion is another way to compare models..

2. MAKE ADAPTATIONS TO MODELS (pairs/individuals) - 10 mins

a. Have students go back to working in their pair (or individually) and make changes to their models to clarify their ideas, add new ideas they heard during the discussion they agreed with, and to add or change the evidence they selected to support some of their claims.
b. By the end of the lesson students should have drawn and written about their ideas to explain the phenomenon and have at least one sticky note with evidence to support one of their claims.

3. HOW HAS MY THINKING CHANGED (individually) - 10 mins

a. Pass back the original models and let students look over them. As an exit ticket, have students write about how their thinking has changed in this unit.

At first I thought… Now, I think…
I used to think… Now, I know…
Before I didn't know how… But, now, I learned that...

Quick Write

How has my thinking changed?

EXAMINING STUDENT WORK

Examine students' model revisions and see how their thinking has changed over the unit. Track changes in thinking on the What-How-Why rubric.

LESSON REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

TASK, TALK, & TOOLS

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

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EQUITY. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue.

_____

_____

_____

_____

PLANNING NEXT STEPS

This lesson sets up students for the next lessons in this unit where they learn how a cat's features (determined by genes and environment) ensure its survival and where they use materials to design a solution to a human problem by mimicking cat features. Consider what you've heard from student talk and seen in student models and on sticky notes to determine what supports students may need in the upcoming lessons.

Lesson 9: Cats in their Environment

OBJECTIVES & OVERVIEW

This lesson gives students the opportunity to talk more about what makes cats similar and what makes them different. Using these ideas, students will then categorize the cats into groups of their choosing based on the similarities and differences they observe. Students will then make connections between how specialized features (based on genes and environment) help cats survive in their specific environment.

Focus Question: How do cats' features and behaviors help them survive?

- Students categorize pictures of cats based on similar characteristics.
- Students make connections between specialized features (determined by genes and the environment) and cat survival.
- Students make connections between genetically based behaviors between parents and offspring and the offspring's survival.

Ambitious Science Teaching: SUPPORTING ON-GOING CHANGES IN THINKING

This practice supports on-going changes in student thinking introducing shared key vocabulary and ideas with which to reason. For more information visit http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

PE 1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Constructing Explanations and Designing Solutions - Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-LS3-1)	**LS1.A: Structure and Function** All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. **LS1.B: Growth and Development of Organisms** Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive.	**Structure and Function:** The shape and stability of structures of natural and designed objects are related to their function(s).

MATERIALS

Per Student (or pair - see teacher decision point):

- Sets of 10 (+) pictures of wild cats in their environment
    - These can be from lesson 4 and/or incorporate student pictures from lesson 1.
    - You want a variety of environments, fur lengths, fur coloring, and textures.
    - Colored copies would be better so students can clearly see the fur color and habitat
- Glue or tape
- Poster paper
- markers

Teacher Decision Point

Decide if students will categorize pictures in individually or in pairs.

Individual:

- Can assess individual student thinking
- Less student talk occurs naturally

Pairs:

- More talk as they negotiate how to categorize pictures
- Strategic partners benefit English Learners or those in need of writing support
- Can assess pairs' thinking

PREPARATION

Print sets of 10 pictures of wild cats - 1 per each student or group

PROCEDURE

Turn and Talk

Which cats seem to be the most similar?

Small Group Work

1. **Activate prior knowledge and experiences (whole class)**
   Introduce this lesson by revisiting observations students had from lesson 1 about the similarities and differences between the different kinds of cats. Then have students turn-and-talk about which types of cats are most similar.

   Have students share out a few of their ideas and introduce the idea of categories.
   Focus question: Why are some cats more similar than others?

2. **Getting the activity started (whole class)**

Back-Pocket Questions

Ask students to work as a team to put the cat pictures into 2 or more categories. Explain that the cats should be grouped in categories based on similarities. Once the students have chosen groups, the pictures should be affixed to a poster for presenting. If possible, students should label the names of their categories.

See the chart to the right for an example of possible categories. It is generated with input from students so lists of observations will vary.

Possible *Cat*egories	
Long fur	Short fur
Spots	Stripes
Solid	Trees
Grass	Snow
Warm Climate	Cool Climate

Whole-class discussion

Compare Charts

3. **Make observations and uncover patterns using questions (small groups)**
   a. Circulate as students make observations and talk about how to categorize the pictures.
   b. As the students make observations, circulate and ask questions about observations and patterns.

Back-Pocket Questions:

- *What makes the cats in this group similar?*
- *How are they different from the other group?*
- *Why would cats have so many differences?*
- *Where in the world might these cats live?*
- *Why do you think these cats have survived in their environment?*

4. **Summarize and select ideas to make public (whole class)**
   As students work on their categories, circulate and observe the kinds of ideas students have. Select 2 or 3 students (or pairs) to share out the categories they chose. Select students who have different ideas.

   Have these students show their poster in front of the class and describe their idea(s) to the class.

   Encourage students to have a short discussion about their categories to ensure that all understand each other's ideas. This is a time for clarifying and elaborating about ideas, not for debating or argumentation.

   Students can use prompts like:

Public Record

Summary Table

- *Why do you think that?* (asking for experience/evidence)
- *Your idea makes me wonder if…* (posing a question)
- *I agree but I thought of the categories this way…* (comparing charts)

Allow students to continue working on charts (gluing pictures and writing category titles) for a few more minutes. They can incorporate some ideas they just heard if they agree.

5. Publicly sharing ideas on summary table (whole group)

a. Observations
b. Learning
c. Connections

Activity	***What did we observe?***	***What did we learn?***	***How does it help us explain Creamsicle's fur color?***
Cats in their environment (Sketch activity or past photo taken during activity here)	Some cats have thick long fur. Some cats have thin short fur. Some cats have solid color fur. Some cats have patterns in their fur color. Some cats have large ears. Some cats have short ears.	Cats have external features (fur length, ear size, etc.) that are specific to the areas in which they live. These features help them survive in their environment. For example: Thick fur acts to keep cats warm while thinner fur helps to keep cats cool. Fur color allows cats to camouflage in their environment which allows them to hunt better and avoid predation. Large ears allow cats to cool themselves.	These external features are as a result of their genes that they got from their parents. Like Creamsicle, wild cats get instructions (genes) from their parents that allow them to survive.

EXAMINING STUDENT WORK

For this lesson, the teacher should use student discussions and posters to track students understanding of how cat's characteristics help them survive in their environment. This task is intended to help you notice what concepts students are already thinking about and which ones are new to most students.

PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class and from their summary chart entry suggestions decide what lesson(s) should come next. Do students need an additional experience or opportunity to demonstrate this NGSS performance expectation?

TEACHER REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

TASK, TALK, & TOOLS

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

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EQUITY. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue.

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Lesson 10: Mom Knows Best

OBJECTIVES & OVERVIEW

This lesson gives students the opportunity to watch kittens in action: sleeping, feeding, playing, and exploring. Students will observe mom and kitten behaviors and then make connections between how their behaviors (based on genes and environment) help cats survive.

Focus Question: How do cats' behaviors help them survive?

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- Students make connections between genetically based behaviors between parents and offspring and the offspring's survival.

Ambitious Science Teaching: SUPPORTING ON-GOING CHANGES IN THINKING

This practice supports on-going changes in student thinking introducing shared key vocabulary and ideas with which to reason. For more information visit http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

PE 1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Read grade-appropriate texts and use media to obtain scientific information to determine patterns in the natural world. (1-LS1-2)	**LS1.B: Growth and Development of Organisms** Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive.	**Patterns:** Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

MATERIALS

For the class:

- Video of a mother cat feeding, grooming, and talking to her young kittens: https://www.youtube.com/watch?v=J17E2bPyOZk
- Video clip of mother calling and feeding older kittens: https://www.youtube.com/watch?v=VM6gvoXN0TM
- Video clip of mother cat helping kitten up the stairs: https://www.youtube.com/watch?v=ZSJQbNCCHtI
- Video explaining the purpose of play for kittens: https://www.youtube.com/watch?v=ZSJQbNCCHtI

- "Cats in their Environment - Mom and Kittens" Class Data Sheet

PROCEDURE

Turn and Talk

What are some examples of cat behaviors?

Present Visuals

Show videos of mom and kittens

Turn and Talk

What doing we see the cats & kittens doing to make sure they survive?

Back-Pocket Questions

1. **Activate prior knowledge and experiences (whole group)**

   Introduce this lesson by telling students they will be learning about ways that mother cats help their kittens survive. Ask students to think about different behaviors they have seen cats doing and how these behaviors might help cats survive. NOTE: They can rely on their personal experiences outside the classroom, or they can think about what the cats were doing in some of the pictures they have seen in the class. Allow students a short time to think quietly to themselves, and then ask them to turn-and-talk with a neighbor.

2. **Introduce the Activity**
   Tell students they are going to watch several video clips of mother cats and kittens. Ask them to look and listen for examples of different cat and kitten behaviors and to be thinking about how these behaviors may help the kittens survive.

3. **Record observations from the video**
   Together, as a class, make a list of observations from the video clips on the "Mom Knows Best Class Data Sheet". Start with a turn-and-talk to have students share observations about what they saw and heard with a partner.

   Record student ideas on the data sheet and post so all students can see.

   Sample student responses of behaviors may include: sleeping, feeding, licking, playing, biting, and meowing.

4. **Uncovering patterns using questions (small groups).**
   Ask students to think about and discuss at their table groups how the behaviors they listed may help the kittens survive.

   Circulate as students talk and ask questions to focus students on patterns.

Back-Pocket Questions

- What would happen to the kittens if they were dirty?
- What do all animals need to survive?
- What do all animals want to avoid?
- How do kittens (and other baby animals) learn?

Public Record

Summary Chart Row

5. **Connections to the Phenomena (whole class)**
    a. Use any information from the activity to complete any missing information from the 'observations' and 'learning' columns. Have students think about how this might add to our understanding of Creamsicle's fur color.

Activity	***What did we observe?***	***What did we learn?***	***How does it help us explain Creamsicle's Cream fur?***
Mom Knows Best (Sketch activity or paste photo taken during activity here)	Mom cats lick their kittens. Kittens drink milk from their mothers Kittens play fight together	Mother cats and kittens each do many things (i.e. licking to clean and play fighting) that help the kittens survive.	Mother cats and kittens do many of the same things because these behaviors are controlled by genes. Survival behaviors are traits that are passed down similar to how Creamsicle's cream fur is a trait that is passed down.

EXAMINING STUDENT WORK

Use student discussions and summary chart to track students' understanding and reasoning about how parents and offspring engage in behaviors that help support kitten survival.

PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class and from their summary chart entry, decide what lesson(s) should come next. Do students need an additional experience or opportunity to demonstrate an NGSS performance expectation? Do students have enough understanding to move into the next lesson?

Mom Knows Best

Class Data Sheet

Directions: Watch the videos to see what the cats and kittens are doing. List the survival behaviors seen in the videos.

Behavior *(What do we see the cats doing to make sure the kittens survive?)*	**Survival** *(How does this behavior help the kittens survive?)*

TEACHER REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

1. **TASK, TALK, & TOOLS**

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of observing cat and kitten behaviors…*
- *The task about … relates to the students and/or their families because…*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

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2. **EQUITY**. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific category of equity:

- Developing relationships and forming an inclusive, trusting community
- Scaffolding for full participation in the culture and language of science
- Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs
- Addressing power dynamics (how a person is seen and responded to by others) to disrupt stereotypes and privilege

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Lesson 11: Copy Cats

OBJECTIVES & OVERVIEW

This lesson gives students the opportunity to explore how humans mimic features of animals. Cats use their rough- textured tongues to keep their fur clean. Humans use the same idea to clean. We use a variety of sponges, rags, and pads of varying textures to clean different surfaces.

Focus question: What are some ways we mimic/copy animals to protect ourselves?

- Students will use different textures to clean a surface.
- Students will make an evidence-based claim about what texture cleaned with surface the best.

Ambitious Science Teaching: Pressing for evidence-based explanations

For this lesson students will be in quadrant 4 (Pressing for evidence-based explanations) If you would like more information about these practices please visit: http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

PE *1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.* [Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]*

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-LS3-1) Use materials to design a device that solves a specific problem or a solution to a specific problem. (1-LS1-1)	*LS1.A: Structure and Function All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1)*	*Connections to Engineering, Technology, and Applications of Science Influence of Engineering, Technology, and Science on Society and the Natural World Every human-made product is designed by applying some knowledge of the natural world and is built by built using materials derived from the natural world. (1-LS1-1)*

Common Core Connections: Paste any ELA or mathematics CCSS connections for this lesson here.

MATERIALS

- *Container to put used scrubbing materials*
- *Container with water to dip scrubbing surfaces in (optional)*
    - *Students could also be given damp scrubbing surfaces to eliminate water at tables*
- *3 plastic plates covered with material per group*
    - *Possible ideas: chocolate syrup, maple syrup, mud, shaving cream, ketchup, liquid soap, liquid glue, glue stick*
    - *To add variation all materials could also be left to dry overnight. There would be 2 groups testing syrup; 1 wet and 1 dry*
- *3 different textures to scrub with per group- many sponges have 2 sides and can count as 2 textures*
    - *Possible ideas: sponge, sock, paper towel, brillo pad*

PREPARATION

- *3 plastic plates covered with a thin layer of material*

Teacher Decision Point

Decide if students will all test the same material of if each group will test a different material

Same material:

- *Will allow you to talk about the same thing as a class*
- *Compare data*
- *Have multiple trials which happens in scientific world*

Different material:

- *Variety*
- *Cats get dirty with different materials- mud, tree sap, etc..*

PROCEDURE

Turn and Talk

Which cats seem to be the most similar?

1. **Activate prior knowledge and experiences (whole class)**
   Introduce idea of humans mimicking (copying) animals' external characteristics to help them survive. Then have students turn-and-talk about ways humans mimic/copy animals. You may choose to list an example of 2 to get them started.
   Examples: bike helmet mimics a turtle shell
   Armor is like fish scales
   Jacket like fur to stay warm

   Have students share out a few of their ideas.

   Focus question: What are some ways we mimic/copy animals to protect ourselves?

2. Getting the activity started (whole class)

Introduce the activity by saying, "Many observations we have made about cats in this unit have been about their fur; color, pattern, and length. Fur is an essential part of a cat's survival. We have talked about how it keeps them warm, dry, and camouflaged/hidden. For a cat's fur to work the best it must stay clean. *Does anyone know how cats clean themselves?*"

Expected student response: water, licking, their tongues

"Remember how we talked about cats having rough tongues? We learned from cats. We use rough textures to help us clean around our house, our dishes, even our cars. Today we are going to look at what texture cleans your surface the best by testing different textures."

Small Group Work

3. Activity

- Introduce materials and textures for experiment.

Activity	***What did we observe***	***What did we learn?***	***How does it help us explain Creamsicle's cream fur?***
Copy Cats (Sketch activity or paste photo taken during activity here)	*Describe the texture of each material used on the plate. For example, chocolate syrup is thick and sticky.*	The best texture for cleaning is determined by the material needing to be cleaned. *For example, hard caked on materials are cleaned more easily with a rough sponge that a smooth one.*	The texture of Creamsicle's tongue is rough to best clean his fur. The rough texture is a trait controlled by genes.

EXAMINING STUDENT WORK

Use student discussions and student data collection sheet to track students' understanding and reasoning about how humans have mimicked cat features.

PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class and from their summary chart entry, decide what lesson(s) should come next. Do students need an additional experience or opportunity to demonstrate an NGSS performance expectation?

Copy Cats Student Data Collection Sheet

Names: _____

Material Tested: _____

Data:

Manipulated Variable: Scrubbing Surface Texture

	Insert scrubbing surface here before printing	*Insert scrubbing surface here before printing*	*Insert scrubbing surface here before printing*
Responding Variable: *How clean the plate is*			

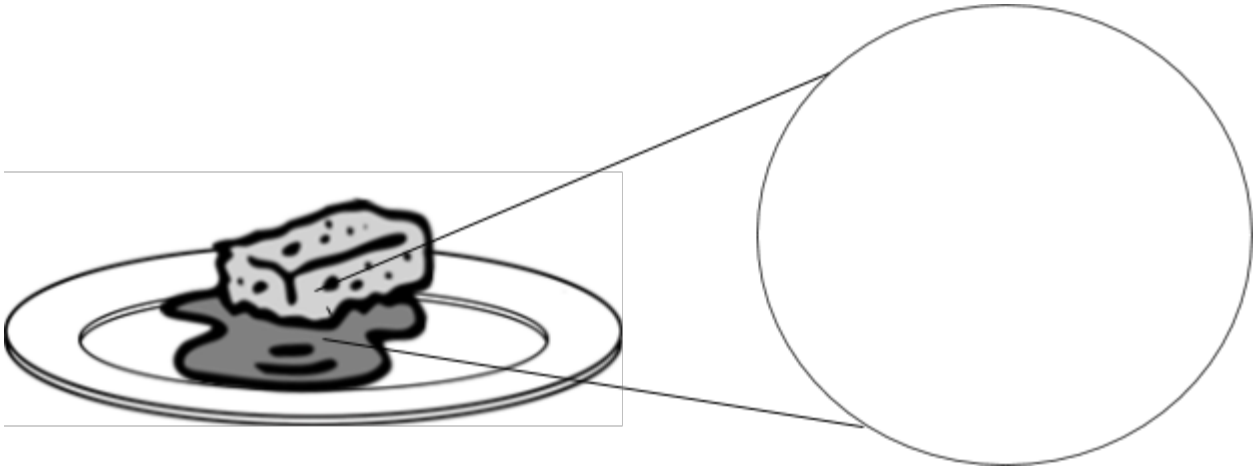
Claim: The texture that cleaned the best was _____

because _____

_____

Draw a ***zoom-in*** of what was happening between your material and texture.

zoom-in



TEACHER REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

1. **TASK, TALK, & TOOLS**

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of observing traits and tracking their frequency…*
- *The task about … relates to the students and/or their families because…*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

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2. **EQUITY**. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific category of equity:

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