

# City of Hope Genetics: Grades K–2

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## Why Study Genetics?

As human genetics and genetic technologies increasingly impact individuals, families, and society, it has become essential for young people to understand and appreciate the science of genetics. By the end of eighth grade, students should know that all organisms have genes and that the information contained within these genes is affected by the physical and social environment in which the organisms live. Knowledge of genetics will allow students to grow into thoughtful members of society who can better understand advances in the science of genetics and how such advances affect their own health and their society. With a foundation in genetics, young people will be able to think critically about how genetic science impacts them and their society, and—if they so choose—to contribute to developments in genetic science and technology in the future.

### NOTE

The background information presented here is a resource for the teacher. It is not meant to be taught directly to students.

## Unit Flow

### **Activity 1: The Ugly . . . Duckling?**

In this session, students listen to the story of the Ugly Duckling. They discuss the ways in which the Ugly Duckling is different from the other ducklings, which helps them identify important characteristics of ducks and swans.

#### **Objectives**

Students will:

- Make observations about how related organisms resemble one another (NGSS 1-LS3-1)
- Make observations about the ways in which organisms of the same kind can differ (NGSS 1-LS3-1)
- Verbalize the characteristics of a type of organism that differentiate it from another type of organism
- Be able to ask and answer questions about key details in a text (ELA/Literacy.RI.1)

### **Activity 2: A Cat of a Different Color**

In this session, students explore a variety of cat photographs to determine the ways in which cats differ and are similar. Students work in teams to study a variety of cat photographs and to determine all the features they can find in cats. They play a game with their teammates that tests their observations of similar and different characteristics among cats.

#### **Objectives**

Students will:

- Make observations to construct an evidence-based account that young animals are like, but not *exactly* like, their parents (NGSS 1-LS3-1)
- Develop a list of observable traits based on photographs (NRC Science Practice 6)

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### ***Activity 3: An Inventory of Me***

In this session, students think about their own characteristics and how they would describe themselves. They gather data about a particular characteristic among their classmates and then make bar graphs of that characteristic, based on their class's data.

#### **Objectives**

Students will:

- Be able to create a self-portrait that highlights their defining characteristics (ELA/Literacy.SL.K.5)
- Be able to communicate the characteristics that they think best describe themselves
- Begin to recognize that traits can either be inherited or acquired (NGSS 3-LS3-2)
- Be able to draw a bar graph (with single-unit scale) to represent a data set with multiple categories (Grade 2: Mathematics 2.MD.D.10)

### ***Activity 4: Growing and Changing***

In this session, teams explore how animals and plants grow and change. They compare juvenile organisms to full-grown organisms and highlight their similarities and differences.

#### **Objectives**

Students will:

- Make observations to construct an evidence-based account for the life cycle of an organism (NRC Science Practice 6)
- Participate in a shared research and writing project (ELA/Literacy.W.1.7)
- With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question (ELA/Literacy.W.1.8)

## Next Generation Science Standards

For additional guidance and clarification on these standards, please refer to “How to Read the Next Generation Science Standards” (<http://www.nextgenscience.org/how-to-read-the-standards>).

### ***Heredity: Inheritance and Variation of Traits***\*

Students who demonstrate understanding can do the following:

**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 that plants or animals share. Examples of observations could include leaves from the same kind of plant that are the same shape but differ in size, and a particular breed of dog that 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	Disciplinary Core Ideas (DCIs)	Crosscutting Concepts
<b>Constructing Explanations and Designing Solutions</b> 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. <ul style="list-style-type: none"> <li>• <b>Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.</b> (1-LS3-1)</li> </ul>	<b>LS3.A: Inheritance of Traits</b> <ul style="list-style-type: none"> <li>• <b>Young animals are very much, but not exactly, like their parents. Plants also are very much, but not exactly, like their parents.</b> (1-LS3-1)</li> </ul> <b>LS3.B: Variation of Traits</b> <ul style="list-style-type: none"> <li>• <b>Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.</b> (1-LS3-1)</li> </ul>	<b>Patterns</b> <ul style="list-style-type: none"> <li>• <b>Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.</b> (1-LS3-1)</li> </ul>

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)

\* Standards in bold are addressed in the unit.

## Background Information

### Activity 1: The Ugly . . . Duckling?

The story of the Ugly Duckling is used here to help students start to recognize traits in organisms and how traits can be similar or different between organisms of different species. The swan in the story is similar in many ways to the ducklings: He hatches from an egg; he has a bill, wings, webbed feet; etc. However, he differs in many ways as well: body color, size, egg color, bill color, foot color, etc.

### Activity 2: A Cat of a Different Color

In this activity, students explore the many and varied traits of cats by looking at pictures of cats. They begin to get a sense that cats can vary while all still being domestic cats. The characteristics of cats that students will most likely notice are coat color, coat pattern, fur length, and eye color.

#### Cat Coat Color

According to cat breeders, cats come in four basic solid colors: black, chocolate, cinnamon, and red. Each color has a dilute (lighter) version and a double dilute version. Why isn't white on the list? Cat breeders count white as the absence of color. The table below lists all the colors.

Color	Dilute Color	Double Dilute Color
White	N/A	N/A
Black	Blue	Caramel
Chocolate	Lavender (lilac)	Taupe
Cinnamon	Fawn	Fawn-based caramel
Red	Cream	Apricot

Cats can also be multicolored and often are bicolored (two-colored), which is also called *piebald*.

#### Coat Pattern

The most common patterns for cat's coats are solid color, bicolor, tabby, tortoiseshell, calico, and combinations of these. Other less-common patterns are also possible.

#### Solid Color

Solid-color cats have only one color and do not have stripes. While some white cats have a black or gray marking on their forehead, they are still considered white cats.

#### Bicolor

Bicolored cats have coats of one color and some white. Patches of white have particular names that are descriptive of their location, such as "mittens" for white paws.

#### Tabby

Tabby cats (or tiger cats, as they are often called) have stripes covering their bodies. Tabby cats often have white chins, and some have white spots in other areas as well.

## NOTES

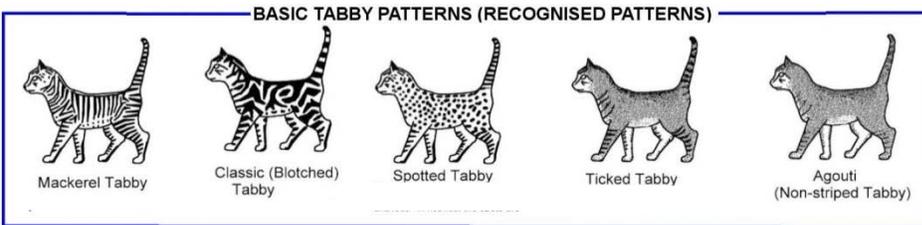


Image courtesy of [MessyBeast.com](http://MessyBeast.com)

### *Calico and Tortoiseshell*

People often confuse calicos and tortoiseshells; however, they are distinct patterns. Calicos are usually mostly white, with large and distinct patches of black and orange occurring around the body. Tortoiseshells are usually mostly black with some orange, and these colors are muddled together, rather than in distinct blotches. Tortoiseshells sometimes have white patches as well.



"A typical calico" by [Howcheng](#) is licensed under [Creative Commons Attribution-Share Alike 3.0 Unported](#)



"Tortoiseshellshorthair" by [Sbharris](#) is licensed under [Creative Commons Attribution-Share Alike 3.0 Unported](#)

The gene that codes for orange/black fur is located on the X chromosome in cats. The X chromosome is a sex chromosome. Male cats inherit an X and a Y chromosome, while females inherit two Xs. The interesting thing about the orange/black fur gene is that a female cat that inherits both alleles of the gene will not be orange even though the orange allele is thought to be dominant. This happens because of a process called *X-inactivation*, in which one X chromosome in each cell of a developing embryo becomes inactivated. When this happens, each cell only has one active X chromosome, and cells that descend from those cells have the same active X chromosome. The colors of fur that develop from those cells are controlled by the allele of the color gene carried in the active X chromosome; therefore, the cat will have patches of black and orange fur. This is why you rarely find tortoiseshell or calico male cats.

### **Cat Fur Length**

Domesticated cats have fur that ranges from short to long. The allele for long hair is recessive to the allele for short hair in cats, so more short-haired cats are found. Hairless cats are rarely found (none are pictured in the reproducible masters), and the gene for hairlessness is recessive.

**Cat Eye Color**

Most commonly, cats' eyes range from green to copper. Domestic cats can also have blue eyes or two different colored eyes.

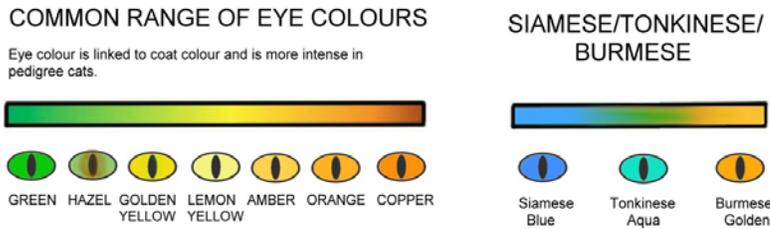


Image courtesy of [MessyBeast.com](http://MessyBeast.com)

**Other Cat Traits**

*Eye Shape*

**EYE SHAPES**

The shape of the eyes is due to the eyelids and other soft tissue surrounding them e.g. the extremely short muzzle of some breeds results in the teardrop shape. Many cats have eyes of indeterminate shapes.

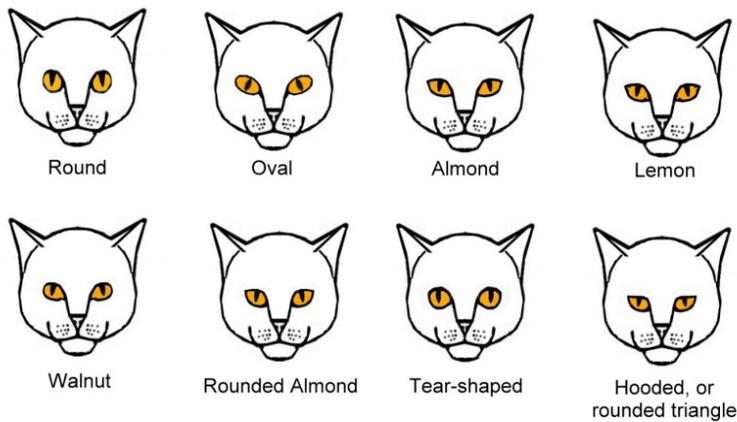


Image courtesy of [MessyBeast.com](http://MessyBeast.com)

*Ear Types*

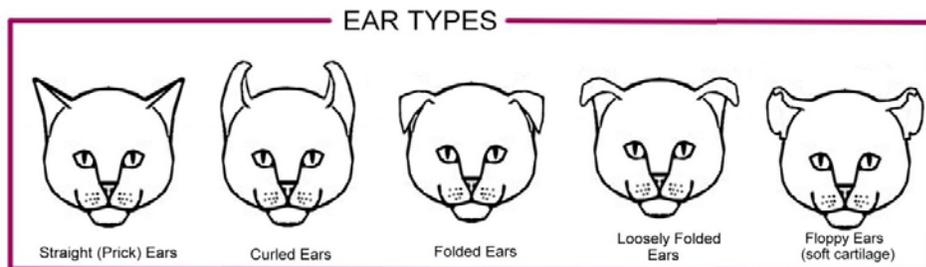


Image courtesy of [MessyBeast.com](http://MessyBeast.com)

### Activity 3: An Inventory of Me

In this activity, students explore the many characteristics of humans by creating self-portraits. Traits they might highlight in their self-portraits include the following:

- Hair color
- Hair texture
- Presence or absence of freckles
- Nose shape
- Eye color
- Eye shape
- Mouth shape

### Activity 4: Growing and Changing

All organisms go through what is deemed a *life cycle*—from birth until death. For organisms with a *simple life cycle*, the young organism looks very much like the adult organism from birth; although their proportions might change as they grow, their overall appearance is similar to that of the adult organism. Most animals, including fish, mammals, reptiles, and birds, have simple life cycles.

Some organisms, such as amphibians and insects, undergo metamorphosis. Amphibians either hatch or are born and live for some period of time in the water, breathing through gills. As they mature, they move onto the land and breathe with lungs.

Insects can undergo *incomplete* or *complete metamorphosis*. For insects that undergo incomplete metamorphosis, the life cycle has three stages: egg, nymph, and adult. Examples of insects that undergo incomplete metamorphosis are grasshoppers, dragonflies, and stoneflies. For those that undergo complete metamorphosis, the life cycle has four stages: egg, larva, pupa, and adult. Most insects, including butterflies, beetles, wasps, and flies, undergo complete metamorphosis.

Plants grow and change as well. The plant life cycle begins with a seed. The seed grows into an immature plant, which is called a seedling. The seedling then grows into a mature plant, which in turn forms seeds that will begin the next generation.

## Glossary

**Acquired trait:** A trait that is not heritable. Acquired traits occur after birth and are caused by disease, injury, deliberate modification, or environmental influence. Acquired traits include modifications such as plastic surgery or tattoos, loss of limbs or scars after accidents or surgery, makeup, and other changes in appearance brought on by accident or choice.

**Allele:** An alternative form of a gene. In diploid organisms, such as mammals, alleles come in pairs—two alleles for each trait—and they are each located at a specific position on a specific chromosome. When the alleles of a gene are different (known as *heterozygous*), one may be *dominant* and the other *recessive*. When the alleles of a gene are the same, they are called *homozygous*.

**Gene:** A unit of heredity that is transferred from a parent to offspring and determines some characteristic of the offspring.

## NOTES

**Inherited trait:** Characteristics that are passed to an organism from its parents and can, in turn, be passed to the organism's offspring.

**Life cycle:** The stages of development of a living organism.

**Nymph:** An immature form of an insect that resembles the adult form of an insect. Nymphs molt as they grow larger.

**Trait:** A feature or distinguishing characteristic of an organism. Traits can be determined by genes and/or the environment. Often a trait is the result of the interaction between the environment and an organism's genes.



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