LESSON 1: How do organisms get all these differences?

PREVIOUS LESSON *There is no previous lesson.*

THIS LESSON

ANCHORING PHENOMENON

3 days

We observe a bull and other animals that have extra-big muscles! We develop initial models to explain what could be causing these animals to have such big muscles. We realize that muscles don't just come in two sizes, large and small. There is a range of musculature on animals. We then explore several other examples of living things that are generally the same, but have wide variations in some of their features. After generating a list of related phenomena, we develop a Driving Question Board and ideas for future investigations.

NEXT LESSON *We will observe images and video animations to figure out that muscles have specific cell and protein structures. We will compare photos and data about muscle cells from extra-big-muscled animals and typical ones to discover that bigger muscles have more cells, more area, and more mass.*

BUILDING TOWARD NGSS

MS-LS1-5, MS-LS3-1, MS-LS3-2, MS-LS4-5

WHAT STUDENTS WILL DO

Develop and/or use a model to predict what is causing these animals to have extra-big muscles.

Ask questions that arise from careful observation of pictures of animals with different musculature and living things that have variations in one or more of their features to seek information about what causes these variations in populations.

WHAT STUDENTS WILL FIGURE OUT

- Some cattle have extra-big muscles that we've never seen before, and we don't know how they got that way.
- In cattle, muscles come in a range of sizes.
- There are lots of variations of characteristics in living things.
- We have a lot of questions and ideas to pursue.

Lesson 1 • Learning Plan Snapshot

Part	Duration	Summary	Slide	Materials
1	15 min	**OBSERVE PHOTOS OF CATTLE WITH SIGNIFICANTLY DIFFERENT MUSCULATURE** Individually record noticings and wonderings in science notebooks while observing photos of a pair of bulls who are generally similar except that one has typical musculature and the other has extra-big muscles.	A-D	Notice and Wonder chart
2	5 min	**MAKE OBSERVATIONS ABOUT OTHER ANIMALS THAT HAVE BIG MUSCLES** View other examples of animals with this significant difference in musculature and begin to look for patterns and possible causes..	E-K	
3	15 min	**CREATE INITIAL MODELS** Individually develop a model to explain how one of these animals might have gotten its extra-big muscles, and what the muscles would look like upon "zooming in."	L-M	Initial Model
4	10 min	**COMPARE AND CONTRAST INITIAL MODELS** Meet with several different partners to find similarities and differences between initial models.	N	Initial Model
				End of day 1
5	15 min	**CONSENSUS MODEL DISCUSSION** Co-construct an initial model as a whole class, finding points of agreement and disagreement about how and why these animals could be different.	O	
6	20 min	**OBSERVE MORE PHOTOS OF GROUPS SHOWING A RANGE OF VARIATIONS** Consider a collection of cattle photos that includes a range of different musculature, and then work in small groups to observe sets of other organisms with varying features. Change groups and discuss the wide range of variation within groups of organisms that might have seemed the same.	P-T	*Cattle Photos*, *Duplicate Cattle Photos*, *Wasp Photos*, *Duplicate Wasp Photos*, *Sunflower Seed Photos*, *Duplicate Sunflower Seed Photos*, *Flamingo Photos*, *Duplicate Flamingo Photos*, *Apple Photos*, *Duplicate Apple Photos*, *Arms Photos*, *Duplicate Arms Photos*, all photos cut and inserted into clear badge holders (see preparation notes at the beginning of this teacher guide), word wall space
7	5 min	**LIST RELATED PHENOMENA** Individually list examples of variations among otherwise-similar organisms.	U	Related Phenomena chart
8	5 min	**ASSIGN HOME LEARNING (OPTIONAL)** Go into the community and find an example of a living thing that has a range of differences in a feature or characteristic.	V	
				End of day 2

Part	Duration	Summary	Slide	Materials
9	13 min	**SHARE RELATED PHENOMENA** Share examples listed during class and/or from home learning of other living things that have variations in a characteristic or trait. Create a class list of related phenomena, and begin to discuss possible causes.	W	artifacts and photos collected from home-learning assignment, Related Phenomena chart
10	5 min	**GENERATE INITIAL QUESTIONS** Consider all the experiences in class so far and write questions we have to eventually form a Driving Question Board.	X	sticky notes, dark-colored marker
11	17 min	**CREATE OUR DRIVING QUESTIONS BOARD** Share questions aloud and group them together with other similar questions to form a DQB to guide the work of the class going forward.	Y	Driving Question Board, space to gather as a class
12	10 min	**CONSIDER IDEAS FOR INVESTIGATION** Students generate ideas for future investigations and consider what data we would want to find or collect to help us answer some of the questions on our DQB.	Z-AA	index card or science notebook, Ideas for Investigation chart

End of day 3

Lesson 1 • Materials List

	per student	per group	per class
Lesson materials	• science notebook • Initial Model • artifacts and photos collected from home-learning assignment • sticky notes • dark-colored marker • index card or science notebook	• *Cattle Photos* • *Duplicate Cattle Photos* • *Wasp Photos* • *Duplicate Wasp Photos* • *Sunflower Seed Photos* • *Duplicate Sunflower Seed Photos* • *Flamingo Photos* • *Duplicate Flamingo Photos* • *Apple Photos* • *Duplicate Apple Photos* • *Arms Photos* • *Duplicate Arms Photos* • all photos cut and inserted into clear badge holders (see preparation notes at the beginning of this teacher guide)	• Notice and Wonder chart • word wall space • Related Phenomena chart • Driving Question Board • space to gather as a class • Ideas for Investigation chart

Materials preparation (30 minutes)

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

Day 1: Make and post a Discussion Norms poster near your DQB space if you haven't already.

Have tape available for students to attach handouts to their science notebooks.

Day 2: Use color copies of the following materials from your kit *Cattle Photos* and *Duplicate Cattle Photos* (or color print them).

- Cut the cattle photos apart so you have 2 sets of 21 single photos.
- Insert each of the photos into a clear badge holder and bind the sets together with a loose leaf ring to save them for future use. You may also choose to laminate the photos.
- If you have a kit from Openscied, these are made for you.

Day 2: Use color copies of the following materials from your kit *Wasp Photos*, *Duplicate Wasp Photos*, *Sunflower Seed Photos*, *Duplicate Sunflower Seed Photos*, *Flamingo Photos*, *Duplicate Flamingo Photos*, *Apple Photos*, *Duplicate Apple Photos*, *Arms Photos*, and *Duplicate Arms Photos* (or color print them). You will have two copies of each of the 5 sets of photos, enough for 10 groups of students.

- Cut apart the photos, keeping them in sets by organism.
- Insert each of the photos into a clear badge holder to save them for future use. You may also choose to laminate the photos.
- If you have a kit from Openscied, these are made for you.

Day 3: Clear a space in your classroom to create a Driving Question Board (DQB) that students can gather around.

Lesson 1 • Where We Are Going and NOT Going

Where We Are Going

Students may come into this unit with different ideas about how animals get such big muscles. They mostly likely will know that diet and exercise play a large role in how big an animal's muscles get. What they might not know is that the animals' extra-big muscles in the anchoring phenomenon are the result of having an allele for the MSTN gene that makes a different shape of a protein called myostatin.

The unit intentionally brings out the effects of environmental factors on trait variation because this is an important scientific concept to understand that will be further built upon in high school. The trait variation we see among living things is almost never due to genetics alone. By the end of the unit, students will grasp that genes and environment are always at play (really there is a gene and environment interaction, but this is beyond the middle school grade-band understanding).

Where We Are NOT Going

There is no need for students to connect the variation in the images they see as the result of inheritance in Lesson 1. In fact, the next couple of lessons explore exactly what the students might predict causes these differences: environmental factors like diet and exercise. Students will realize in Lesson 4 that environmental factors alone cannot explain all the variation they see in the extra-big muscled animals, which will be a natural turning point to a focus on inheritance. Therefore, it is not necessary to have questions about family or inheritance or genes on the DQB at this time.

LEARNING PLAN for LESSON 1

1 · OBSERVE PHOTOS OF CATTLE WITH SIGNIFICANTLY DIFFERENT MUSCULATURE

15 min

MATERIALS: science notebook, Notice and Wonder chart

Introduce an interesting phenomenon.

Say, *I've got some interesting pictures of animals to show you. When I first saw them, I found them very surprising. I want us to take a look at them as a class.*

Set up Notice and Wonder charts in science notebooks. Display **slide A**.

SCIENCE NOTEBOOK

If you haven't already set up science notebooks for this unit, direct your students to count off about 4 pages to use as a table of contents. They will also need to set aside about 10-15 pages at the end of the notebook to use for the Progress Tracker (starting in Lesson 2).

Say, *You'll use your science notebooks to record what you notice and wonder about them, so let's set up a chart now so we are ready to record our thoughts.*

ADDITIONAL GUIDANCE

If you anticipate that your students need it, give a reminder about keeping voices off so everyone can have quiet think time. You could say something like, *We want to gather as many ideas as possible, and if you say something out loud, your idea might "infect" other people's brains and make them forget their own ideas. We will have time to share all of our thinking in just a few minutes, but for now, it's important to keep your thoughts to yourself.*

Independently record noticings and wonderings about the bull photos. Say, *The photos I'm going to show you are of actual animals - these photos have not been altered to make them look like this. Take a couple of minutes to look at them carefully and record what you notice and wonder.*

Display **slide B**. Give students about 2 minutes to work silently on the Notice and Wonder chart in their science notebooks.

Turn and talk about the bull photos. After students have had some time to work on their own, display **slide C** and direct them to share their thinking with a neighbor. Remind them to refer to specific details in the photos to support their ideas.

Share noticings and wondering with the whole group in an Initial Ideas Discussion. Display **slide D** and record students' thinking on a Notice and Wonder chart as they share.✱

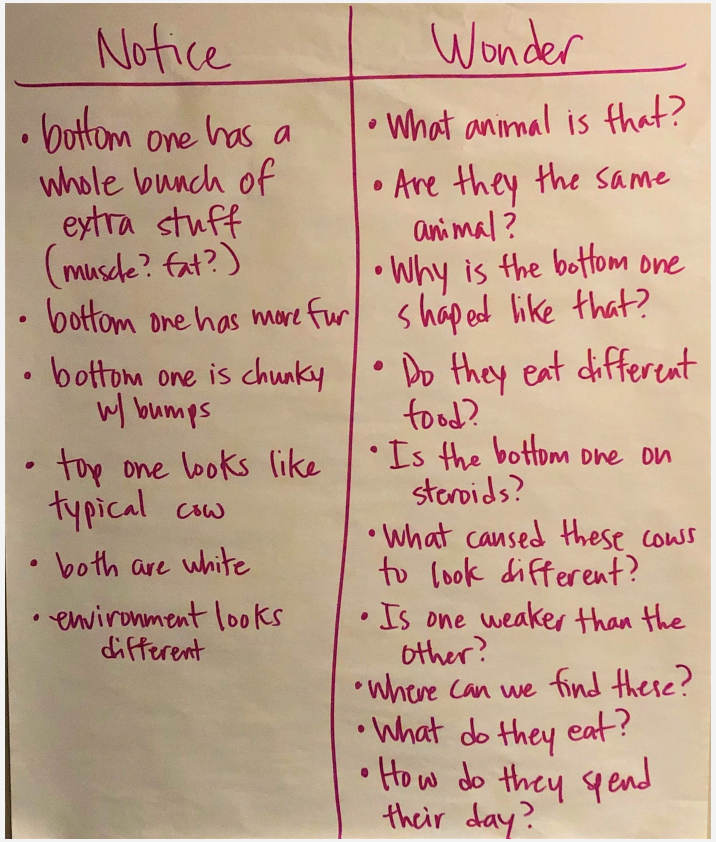
✱ ATTENDING TO EQUITY

Students may refer to the pictures of the bulls as "cows" or "cattle" or some other word. Whatever name they use in their initial ideas is fine. For your background knowledge, the following are definitions of the specific terms:

- cattle is the plural for males and/or females
- a bull is a fertile male
- a steer is a sterile male
- a cow is a female who has had a calf
- a heifer is a female who has not had a calf

If students ask if the images are of males or females, say, "That's a good question that we might want to find out." Add the question to the "wonder" side of the Notice and Wonder chart. We don't want the sex of the cattle to become a stumbling block. Even though the pictures of the cattle are of males, we don't want kids to think that only males can develop the large musculature. In later lessons, kids will see evidence that females can also have the heavily muscled phenotype.

See example of classroom Notice and Wonder chart shown here.



Notice	Wonder
• bottom one has a whole bunch of extra stuff (muscle? fat?)	• What animal is that?
• bottom one has more fur	• Are they the same animal?
• bottom one is chunky w/ bumps	• Why is the bottom one shaped like that?
• top one looks like typical cow	• Do they eat different food?
• both are white	• Is the bottom one on steroids?
• environment looks different	• What caused these cows to look different?
	• Is one weaker than the other?
	• Where can we find these?
	• What do they eat?
	• How do they spend their day?

KEY IDEAS

Purpose of this discussion: (1) to engage students in thinking very carefully about these photos, (2) to generate a range of ideas to cultivate curiosity and uncertainty, and (3) to build student agency in science discussions. A diverse range of ideas is something to celebrate here!

Listen for these ideas:

- Accept all student answers and be careful to not evaluate them as correct or incorrect.
- While there may be differences in the posture of the bulls, the settings they're in, and so forth, we want to be sure students all see the difference in their musculature most of all.

Suggested prompts	Sample student responses	Follow-up questions
What did you notice about these animals?	*The bull on the bottom has huge muscles!* *The one on the bottom is stronger than the one on top.* *They sort of have the same color hide, but the one on the bottom has some differently colored places.*	*Thank you for sharing.* *What in the photo makes you think that?*
What are you wondering?	*Are they male or female?* *How did they get this way?* *Does this happen in other animals?*	*Who can add on to the idea that we are building?* *Can you say more about that? What do you mean by that?* *So let me see if I get what you are saying. Are you saying that …? (Leave space for the original student to agree, disagree, or say more.)* *Who can repeat this idea or put it in your own words?*

2 · MAKE OBSERVATIONS ABOUT OTHER ANIMALS THAT HAVE BIG MUSCLES

5 min

MATERIALS: science notebook

Observe other animals with extra-big muscles. Display **slides E through K** one at a time, allowing some time for students to notice and comment on the images. Keep this part moving, no more than 20 seconds per slide. No need for students to write down anything. The goal is to broaden out to more examples of animals that have really large muscles. The large musculature isn't just a one time thing that happened in one animal.

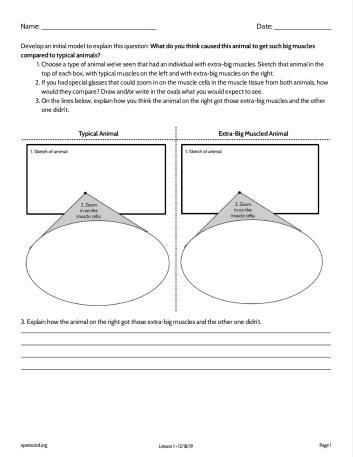
Suggested prompt	Sample student response
What do you notice?	*There are so many different animals that have extra-big muscles!* *The black-and-white cattle have different coloration than the picture we originally saw, but they still have big differences in the muscles.* *It's interesting that the pigs are on the same farm, but have such different musculature.*
What are you wondering now about these animals?	*How are these animals getting so jacked? Do they go work out at the gym?* *How does this work?*

3 · CREATE INITIAL MODELS

15 min

MATERIALS: GE.L1.HO

Create initial models. Display **slide L**. Distribute the handout *Initial Model*. Give directions for drawing quick stick animals in the boxes for step 1 so students don't spend too much time on their animal drawings. More time and effort can go into the thinking about steps 2 and 3. Allow students about 10 minutes of quiet independent work time. While they're working, encourage students to record on the back of their handouts or in their notebooks any questions they have right now. Display **slide M** so students can refer back to the animal examples while they work.✱



Name: _____ Date: _____

Develop an initial model to explain this question: **What do you think caused this animal to get such big muscles compared to typical animals?**

1. Choose a type of animal we've seen that had an individual with extra-big muscles. Sketch that animal in the top of each box, with typical muscles on the left and with extra-big muscles on the right.
2. If you had special glasses that could zoom in on the muscle cells in the muscle tissue from both animals, how would they compare? Draw and/or write in the ovals what you would expect to see.
3. On the lines below, explain how you think the animal on the right got those extra-big muscles and the other one didn't.

Typical Animal	Extra-Big Muscled Animal
1. Sketch of animal:	1. Sketch of animal:
2. Zoom in on the muscle cells:	2. Zoom in on the muscle cells:

3. Explain how the animal on the right got those extra-big muscles and the other one didn't.

_____

_____

_____

_____

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✱ SUPPORTING STUDENTS IN ENGAGING IN DEVELOPING AND USING MODELS

Remind students that we are using this model to predict and describe what we think may be causing this phenomenon, so the goal of this initial model is to get students' thinking down on paper, not to have the "correct" answer.

SCIENCE NOTEBOOK

You may instruct students to tape their initial models in their science notebooks, or you might want to collect the initial models as a pre-assessment. If initial models are collected, students can tape them in their science notebooks when they are returned.

4 · COMPARE AND CONTRAST INITIAL MODELS

10 min

MATERIALS: GE.L1.HO, science notebook

Compare models with partners. Display **slide N** and direct students to make a T-chart in their science notebooks to collect similarities and differences between their models. Briefly explain the instructions for Stand Up, Hand Up, Pair Up, and give students about 8 minutes to mingle, comparing models with different partners. Students should record similarities and differences in their T-charts while they are talking with different partners. If other questions come up during their conversations, students should record those questions in their science notebooks, too.

ADDITIONAL GUIDANCE

"Stand Up, Hand Up, Pair Up" is a Kagen strategy that works like this: When you say go, students stand up with their hand up in the air (and handout, notebook, and pen in the other hand). They roam around the room to find another person whose hand is also up (the first person they make eye contact with), and go talk with that person. After they've recorded similarities and differences, they both put their hands up again to go find new partners (with someone else whose hand is also up again). Students continue mingling to find partners as they're ready (no set signal from the teacher to rotate). See https://www.kaganonline.com/ for more information.

Pause here for now. Say, *Thank your last partner for sharing with you, and thanks to you all for your great thinking today. Next time we're together, we will combine our ideas into our consensus model - I'm looking forward to it!*

ASSESSMENT OPPORTUNITY	Remember to collect initial models as a pre-assessment opportunity at the end of class. (See assessment guidance section for more information.)

End of day 1

5 · CONSENSUS MODEL DISCUSSION

15 min

MATERIALS: None

Bring students together in a Scientists Circle for a Consensus Discussion. Display **slide O.** See the *OpenSciEd Teacher Handbook* for more information about Scientists Circles and developing norms to make these discussions productive. Tell students that the goal of this discussion is to figure out areas of agreement and disagreement in our initial models. Knowing where we agree and disagree will help us figure out how we might want to proceed in figuring out how these animals might have gotten their different muscles.

KEY IDEAS	**Purpose of this discussion:** There are two goals of this discussion: (1) to generate a variety of initial ideas about what is going on in these animals and (2) to scope out the territory of what the class does and does not understand in order to problematize what the group needs to figure out. As such, it is again important to accept all student responses and to encourage students to share their ideas. Furthermore, it is important to highlight areas of disagreement and help students clearly explain their thinking in these areas. Be careful not to respond favorably to any one idea over others so as not to "give away" the reasons for the big muscles that the class will investigate as the unit progresses. **Listen for these ideas:** • We agree that some animals have larger muscles than typical animals and something must be different at the cellular level. • We agree that there could be a number of possible factors causing this muscle difference: what the animal eats, how much it exercises, and whether its family members had those same muscles. • We're not sure if the extra-big muscled animals have more cells, larger cells, or maybe both. Or maybe the cells are more spread apart in typical animals. • We see differences in many other areas as well.

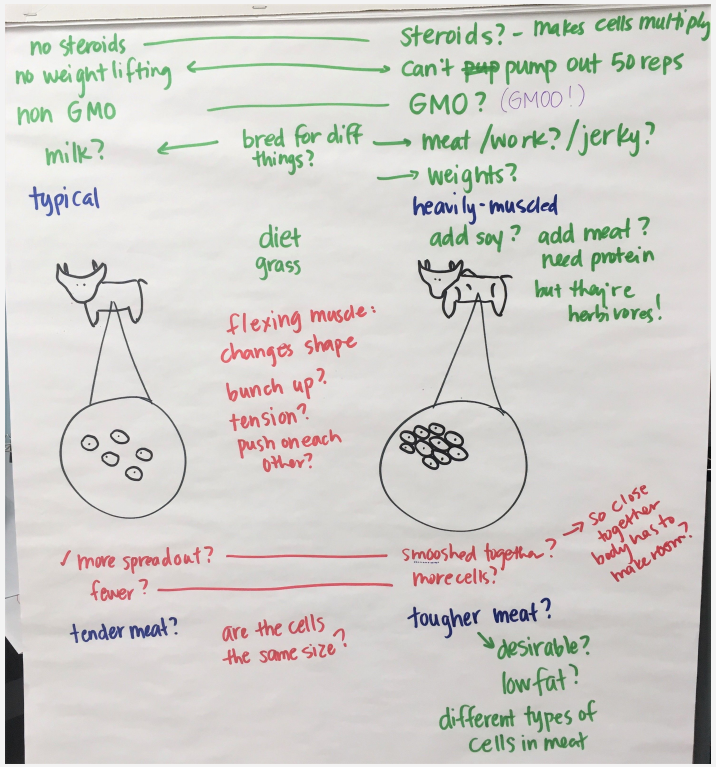
ADDITIONAL GUIDANCE	Science discussions are most productive when all students can see and hear one another. It is helpful to establish norms for whole-group and small-group science discussions. See the *OpenSciEd Teacher Handbook* for more guidance on establishing classroom norms. You may wish to have students help you create the norms or you may wish to create the norms yourself and then share them with students. If you create the norms yourself, consider spending some time thinking with students about why the norm is important, what it might look and sound like when students are "demonstrating" the norm, and how not following the norm could affect how others feel and interact with the learning community.

Represent areas of agreement and disagreement in a consensus model. It is unlikely that you will have complete consensus about the possible causes of these muscle differences. Instead, students will likely propose a handful of causes that everyone can probably agree are worth investigating, such as: (1) what it eats, (2) how much it exercises, and (3) whether its family members had those same muscles.

Also, students may not agree on whether extra-big muscled animals have bigger and/or more muscle cells than typically-muscled animals. Leave both of those possibilities in the model with a question mark. It is okay to have several possible causes to investigate later.

Throughout the discussion, and again toward the end, remind students to record any questions they have right now in their science notebook so we do not lose those questions.

See the example consensus model shown here.



6 · OBSERVE MORE PHOTOS OF GROUPS SHOWING A RANGE OF VARIATIONS

20 min

MATERIALS: *Cattle Photos*, *Duplicate Cattle Photos*, *Wasp Photos*, *Duplicate Wasp Photos*, *Sunflower Seed Photos*, *Duplicate Sunflower Seed Photos*, *Flamingo Photos*, *Duplicate Flamingo Photos*, *Apple Photos*, *Duplicate Apple Photos*, *Arms Photos*, *Duplicate Arms Photos*, all photos cut and inserted into clear badge holders (see preparation notes at the beginning of this teacher guide), word wall space

Suggest a question about our consensus model. Display **slide P**.

Say, *We developed a consensus model to explain the differences between individuals with "extra-big" versus "typical" muscles, but as we have been talking about this, I have been thinking... Are there only two sizes of muscles that cattle can have: extra big-muscled and typical or do you think that there can be other sizes of muscles too? Turn and talk with a neighbor. Share what you think and decide if you agree with each other's ideas or not, and explain why.*

Give students a minute to turn and talk with a partner.

Say, *I have some photographs of 21 different individual cattle we can use to help us try to find additional evidence to support or refute these initial arguments you shared with your partners.*

Observe and compare other cattle photos. Display **slide Q**. Divide the class in half, and give each group one set of the cut-out cattle photos. (The goal is to have one or two cattle photos for each student; if your class is 21 students or fewer, you need only one set of the photos.) Direct students to compare the muscles of their cattle to others in the group, inviting students to form a loose "line" of cattle photos along a continuum of how muscled the cattle are.

Suggested prompt	Sample student response
What do you notice about the muscles of these cattle?	*There is a range of muscle, from typical to huge with lots of other amounts in between.*
If we looked at other living things, do you think we would see a range of differences in a characteristic, too? Or do you think most characteristics come in only 2-3 categories like small, medium, large?	*Answers will vary.*

Work in small groups to observe and sort photos of other organisms. Display **slide R**. Explain that each group of students will get a collection of photos.

Say, *I have several images of different living things. As we looked at the range of muscles in cattle, what other characteristics did we see or think about that can be varied in groups of living things? In a few minutes, each member of your group must be ready to share what his or her group discussed with other classmates.*

Form 10 groups, and distribute sets of photos. Two groups of students will have the same set of photos. Give students 7 minutes to work with their photos.

Students should study, discuss, and sort or organize these photos to determine:

1. What is similar about these animals? What is different?
2. How could you sort these photos to put organisms into different groups based on what is similar and different between them?
3. Record the number of different groups you decided to sort your individuals into.

Students should write down their answers to the 3 questions on the slides in their science notebook.

ADDITIONAL GUIDANCE	We made a deliberate choice not to use the word "species" in this unit. Understanding this classification is beyond the scope of this unit, and the words "group" and "population" (in Lesson 4 and beyond) better fit the needs of work in this unit.

"Jigsaw" to switch groups and discuss differences. Rearrange groups so the groups now contain about 5 people per group, 1 person representing each different photo set. Have individual students take a photo or two from their set to refer to as they share with the new group.

Display **slide S**. Tell students to share with their new groups

- what features or differences they used to categorize the differences among the individuals in the group, and
- how many groups they made to categorize those differences.

Debrief findings from the photo set activity. Gather students together in a whole group again and display **slide T**. Briefly discuss thoughts about the photo sets, pushing for the key idea that there can be a wide range of variation within groups of organisms that at first glance might have seemed the same.

Suggested prompt	Sample student response
In what ways were the collections of photos you saw different? The same?	*The sunflower seeds were different sizes, and their stripes were different even though they were the same shape and colors.* *The apples have different patterns on them - all reddish and greenish, but different amounts, stripes or spotted. There are some with different shapes and sizes.* *The wasp faces were wild! They're all wasps, obviously, with eyes and antennae and such, but they look different! The coloring and patterns of their faces are all unique.* *The flamingos were mostly pinkish orange, but there were a couple who were much lighter, and some had darker colors on different parts of their wings or necks or legs. It was hard to tell if they were the same size since they weren't all standing the same way.* *The people's arms were different lengths... even their fingers were different lengths.*

Define trait and variation. Point out to students that scientists have specific words to use when describing the differences we've been talking about.

Say, *It gets tricky to talk about these differences, so we're going to add a few terms to our science words wall to help us have discussions about this. You described the general categories or characteristics you used to organize your organisms, such as length, pattern, or color - these are called traits. The number of differences within a category, such as flamingos that are super pink, light pink, orangish, or almost all white - these are the variations within the trait. So the trait includes all the variations in that category. Who can give us another example using these words?*

Suggested prompt	Sample student response
What's another example of a trait and some of its variations?	*One trait of the apples was their color. There were green, red, and "both" variations.* *We looked at the trait of length (or size) with the sunflower seeds. The variations we saw were like long (big), medium, and short (small).* *The wasps' faces... is the trait how their face looked? There were so many different variations it was hard to sort them - spots on their eyes or not, whether their "nose" was reddish or black or yellow, and more!*
What can we say about the amount of variation we see for these different traits you identified in each group?	*There aren't just two choices of the variations in a trait, like pink or white, or long or short....* *These differences all come in a wide variety - there's a range of variations for each trait.*
Let's think back about the differences in muscle size. How can we use our new words to describe what we find for the range of muscles in cattle?	*There aren't just two choices about how to describe muscle size, either. The trait is muscle size and the variations are all different sizes.*

Suggested prompt	Sample student response
Would we expect to find only two possible variations in every cattle population, or more?	*Way more!*

ADDITIONAL GUIDANCE	Collect the photos and reorganize them into their original sets while students are listing related phenomena in the next activity. Keep the laminated photos to use with other classes in the future.

7 · LIST RELATED PHENOMENA

5 min

MATERIALS: science notebook, Related Phenomena chart

List related phenomena. Display **slide U**. Direct students to the next clean page in their science notebooks and have them title it "Related Phenomena."

Say, *Like the sunflower seeds or wasps were generally the same but had a range of differences or variations in some characteristic(s) or trait(s), what other examples of living things have you seen that are basically similar but have a range of differences or variation in a feature or trait?* Give students 3 minutes to create their lists, working silently and independently.

ADDITIONAL GUIDANCE	If students are struggling to come up with ideas, prompt them to think about their own pets compared to a friend's pet, animals, or plants they see on the walk to school, or even the foods they eat that are living things, such as apples or bananas.

8 · ASSIGN HOME LEARNING (OPTIONAL)

5 min

MATERIALS: None

Assign home learning. Display **slide V**. Explain the assignment.✱

Say, *Find another example of a type of organism that shows differences between individuals in some characteristic or trait. Find at least two of that type of organism. Look around for where you can find a group of these organisms in your community. The walk home from school, or imagining a trip to the grocery store might be good places to start. We will discuss our related phenomena from class and home next time we meet, and the more ideas, the better!*✱

✱ ATTENDING TO EQUITY

At some point during this unit, your students may bring up the idea that they may (or may not) share traits with members of their families. Recall that not all of your students may be living with or in touch with their biological family members, and therefore would not be able to compare themselves with their parents, grandparents, siblings, and so on. In order to be sensitive to these situations, you should not direct students to explore inheritance with their families. The home learning in this lesson should be focused on non-human examples of trait variation.

✱ ATTENDING TO EQUITY

A key element of the Anchoring Phenomenon routine is letting students share their experiences with related phenomena. The home-learning assignment is a great way for kids to connect more concretely to their world and to bring up and share examples from their surroundings. This assignment can help all students connect to the phenomenon and increase investment in figuring out the broader question of how living things get variations in their traits.

End of day 2

9 · SHARE RELATED PHENOMENA

13 min

MATERIALS: science notebook, artifacts and photos collected from home-learning assignment, Related Phenomena chart

Share related phenomena examples. Display **slide W**. Invite students to share the examples they listed in their science notebooks during the previous class and to show and tell about any photos or other artifacts and ideas they collected during the home learning. Accept all student responses, as long as they are related to differences among living things, and try to draw out a wide variety of related phenomena. Keep a public record (on chart paper or in digital form) of the related phenomena to revisit later in the unit. You may also have students add their classmates' ideas to their own list of related phenomena in their science notebooks. Some possible related phenomena may include the following:

Suggested prompt	Sample student response
What other examples have you seen of living things that are basically similar, but have a range of differences or variation in a characteristic or trait? *In your example, try to label the trait and variations for us, so we can practice using those words.*	*My dog looks very different from my neighbor's dog, and both of them look very different from another dog we know down the block. The traits could be types of fur (my dog is super fluffy, my neighbor's is kind of curly-haired, and the other one has like regular flat, short fur). But they're also different sizes and colors, so those would be different traits.* *I thought about the trait of height, and the variations are like tall, average, and short. I'm pretty tall, and so are my brother and my dad, and my grandpa was tall, but my mom is average height. My friend who is my same age is short.* *The grocery store sells flowers (called carnations, I think) that are are all different colors, including a bright blue that I don't think grows in nature, but some of them have color just on the edges of the petals and some have stripes on the petals and some have bright solid colors. So the trait is their color, and the variations are pink, white, red-edged, and that crazy blue.* *When I have grapes to eat, they're all the same shade of reddish-purple color, except for the green ones, but not every grape is the same shape. There is a range in how round or oval each grape is. So the traits are the color or shape, and the variations are red, purple, green and round or oval.*

10 · GENERATE INITIAL QUESTIONS

5 min

MATERIALS: science notebook, sticky notes, dark-colored marker

Generate questions about living things having differences even though they also seem the same. Direct students to consider all these related phenomena we just listed, along with all the work we did on our initial models and with our Notice and Wonder chart (be sure these are within view).

Say, *So we have been thinking about all this variety among living things. Let's get ready to pool together and organize what we've been wondering. Let's take some time to write our questions so they'll be clear to others when we start building our Driving Question Board. Look back at the questions you had in your Notice and Wonder charts, and that you recorded during our modeling, and add those questions, as well.*

Display **slide X**, and review instructions for writing questions on sticky notes.✱

✱ ATTENDING TO EQUITY

Asking questions in everyday language allows students to share their thinking or experiences, even if they do not have the appropriate scientific vocabulary yet. This is helpful for emergent multilingual students because by not requiring scientific words at the onset you do not limit their participation in classroom discourse.

11 · CREATE OUR DRIVING QUESTIONS BOARD

17 min

MATERIALS: Driving Question Board, space to gather as a class

Begin constructing the DQB. Display **slide Y**. Say, *We have a lot of really good questions about these phenomena. It is important that we hear everybody's questions, and we might find that we have questions similar to some of our classmates' questions. We are going to create a Driving Question Board to help us group and organize our questions so they can help guide our investigations into what is going on with these extra-big muscle and other differences in living things. The Driving Question Board will help us keep track of what it is we are wanting to figure out.*

Students regroup in a Scientists Circle and bring their questions and a pencil with them.

Instruct students to share their questions, one by one, with the whole group. Explain to students how you will create the DQB:

- The first student reads his or her question aloud to the class, then posts it on the DQB.
- Other students raise their hands if they have a question that relates to the question that was just read aloud.
- The first student selects the next student whose hand is raised.
- The second student reads his or her question, says why or how it relates, and posts it near the question it most relates to on the DQB.
- That student selects the next student.
- Continue until everyone has at least one question on the DQB.
- If the question doesn't fit with any questions that are already on the board, students should create a new cluster.

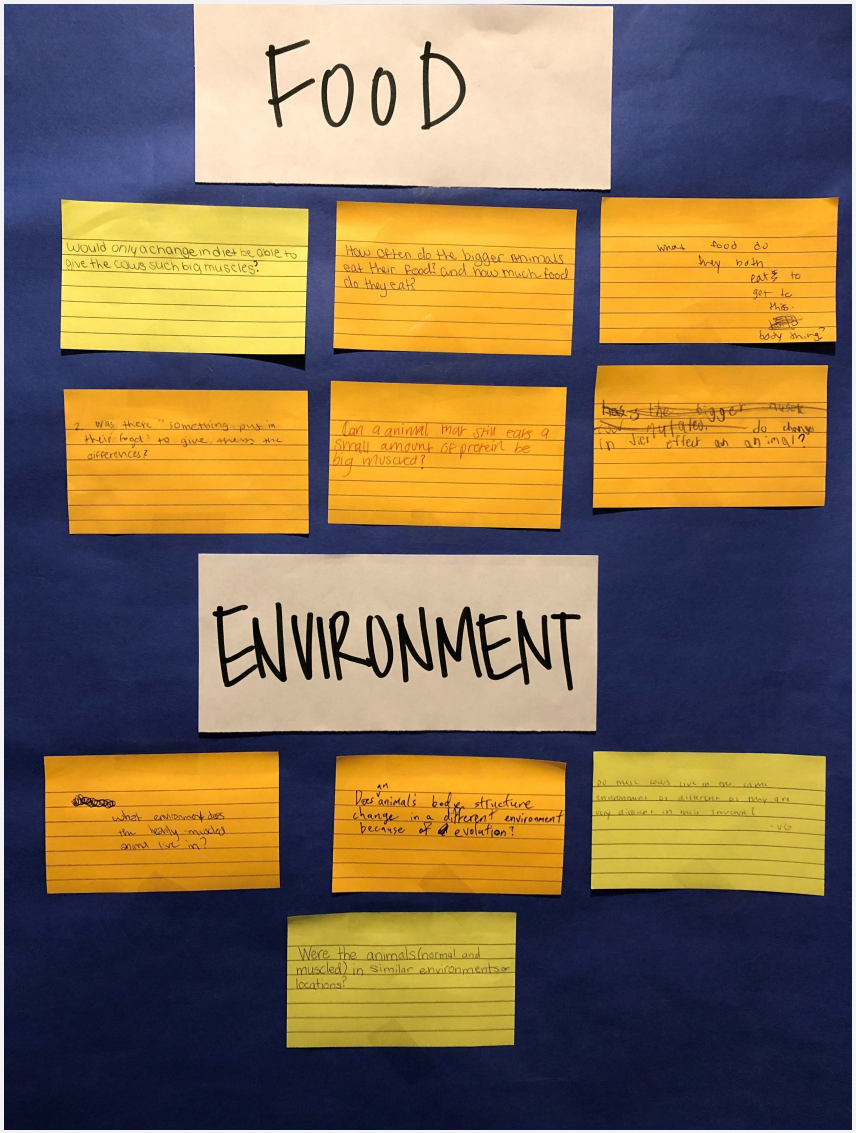
Some of the questions students have might include:✱

- Did those big-muscled animals work out?
- Did those big-muscled animals take steroids?
- Why don't all of the cattle have big muscles?
- How can things like big muscles or height or hair color "run" in a family?
- Why do different kinds of animals (like dogs) look so different?
- How can eating certain foods help you/animals grow more?
- How do muscles actually grow or get bigger?
- Can chemicals make animals "mutants" (like superheros)?
- Why do we have different types of birds (or cats or dogs or apples, etc.)?
- Why are there such big differences between all the animals or plants and/or humans on the planet? How did that happen?

✱ ATTENDING TO EQUITY

The first priority during the formation of the DQB is reinforcing a classroom community wherein all ideas are valued. As such, everyone should have a question on the board. Use your judgement on how to press students to form "how" and "why" questions. If a student struggles with sharing, encourage him or her to go public with question(s) as they are, rather than focusing specifically on forming a "how" or "why" question.

Label the questions. After all students have shared their questions, you will have several different clusters of questions on the DQB. As a class, decide on "umbrella" questions or topics for the clusters of questions and label them. Then, if you haven't already done so, draw students' attention to the scope of all the sub-questions that seem related to figuring out how organisms get all these differences. Propose and post this question at the top of the DQB as the driving question for all of the sub-questions under it: "Why are living things different from one another?" See photos of one classroom's DQB here.



TYPICAL MUSCLES VS. SUPER BIG MUSCLES

Are animals that are heavily muscled more susceptible to sickness?

What causes the animals to get such a big difference in size when they're both the same animal?

Was the muscular cow made muscular with a substance like drugs or was it born like this?

How is the ratio determined?
(Asking for ratio: (muscled animals : normal animals) & how was it found

How much stronger is the muscled animal?

How do these animals with large muscles adapt to their surroundings?

Where did these changes start to appear?

Did the muscular cows previous have the same condition as him/her?

Were genetics involved in any way to make these animals more muscled?

Does age affect how big an animals muscles are?

What ~~was made~~ actions caused these changes?

How do the big muscles form?

Can having more muscles change their bone structure?

Did the muscles from muscular animals come from natural causes or artificial causes?

How much do they both weigh?

Other than just the muscles, what other differences a animal with muscles has to animals w/ their?

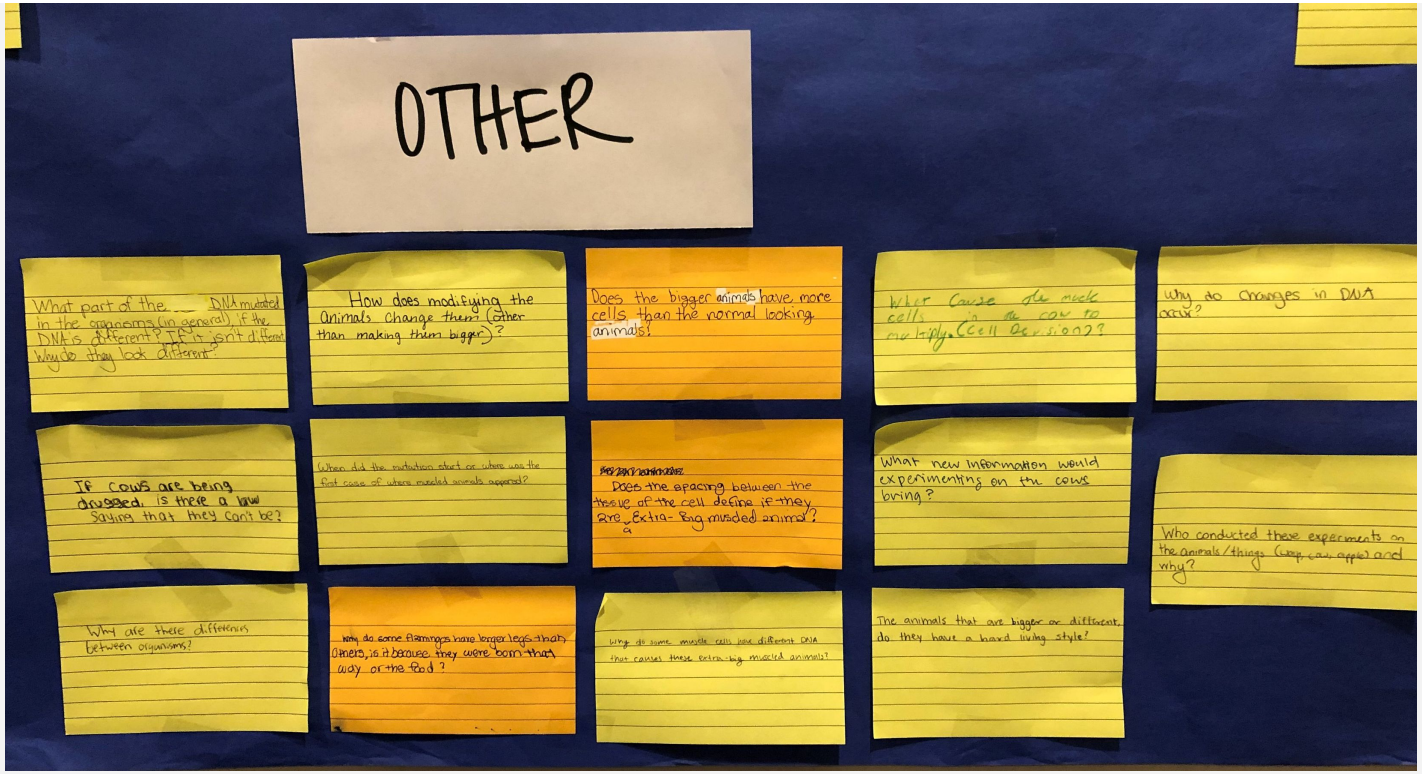
Is the variation of the 2 specimens natural?

When was the muscled cow noticed to be different compared to a normal cow?

How do big-muscled animals become like that?

Why do people want to "modify" the cows to make them stronger & bigger?

What part of the DNA mutated in the genome to grow(?) if the DNA is different? If is isn't different why do they look different?



12 · CONSIDER IDEAS FOR INVESTIGATION

10 min

MATERIALS: index card or science notebook, Ideas for Investigation chart

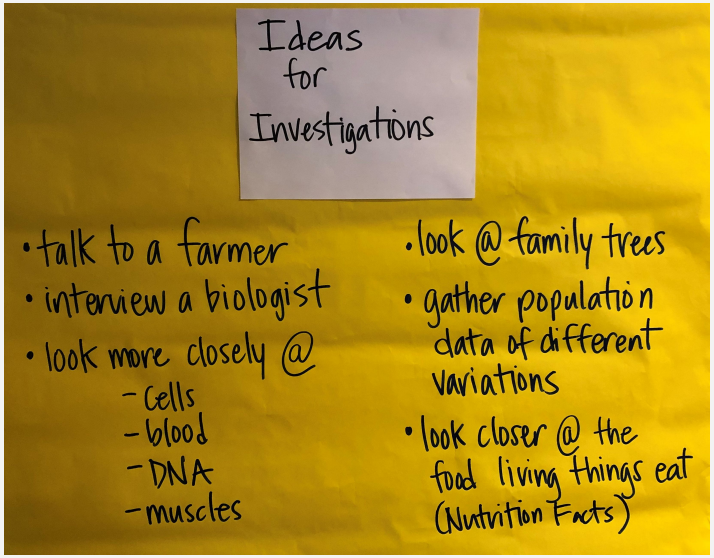
Generate ideas for investigation. Display **slide Z**. Have students generate ideas for 2 minutes in their science notebooks or on an index card.

Say, *We have so many ideas to explore! How could we start to investigate the answers to some of these questions? Make a chart in your science notebook for Ideas for Future Investigations and Data We'll Need. Take a few minutes to write your thoughts about how we might be able to try to answer some of the questions we have on our DBQ.*

ASSESSMENT OPPORTUNITY	If you would like to more easily collect students' ideas for investigations and data we'll need, have them write on an index card instead of directly into their science notebooks. Read students' ideas as a formative assessment, then return them to students at the beginning of Lesson 2 so they can put them into their notebooks to keep.

Share ideas for investigation. Display **slide AA**. Direct students to turn and talk with a neighbor to share one or two of their ideas. After a moment of partner talk, ask student pairs to share one idea with the whole class. Move around the room to each pair and record these ideas on an Ideas for Investigation chart for the whole class to keep as a reference. The goal here is to hear a variety of ideas that we may be able to investigate over the course of the whole unit.

See example Ideas for Investigation chart shown here.



ADDITIONAL GUIDANCE

This list of Ideas for Investigation can be revisited throughout the unit just like the DQB. When a future lesson involves an investigation like one the class suggested, take time to point that out. If your students suggest ideas that are not planned in the unit but that you feel would be productive to pursue, use your discretion and your knowledge of the storyline to decide where these additional investigations would best fit so the unit's punchlines continue to build on one another.

Say, *We have so many great ideas to investigate! Remember, we cannot do all of this at once, and when we make progress on one question, that progress usually helps us answer others. But we really could start anywhere because all of our questions are connected! That's what we'll start doing next time!*

Additional Lesson 1 Teacher Guidance

SUPPORTING STUDENTS IN MAKING CONNECTIONS IN ELA

CCSS ELA SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.

If students are reluctant to participate in whole-group discussions, check in with them during partner or small-group work time to be sure they feel prepared with ideas to share. If you find students struggling to engage with the ideas of others during discussion, revisit your classroom norms and consider posting sentence stems to support how students respond to each other during discussions.