



## Texas Ag in the Classroom STEM Lessons

# ANIMAL SCIENCE | SURVIVAL OF THE FITTEST: ADAPTION & EVOLUTION

## AT A GLANCE

### **Grade Level/Subject**

10<sup>th</sup> grade biology

### **Overview**

Students will take an in-depth look at cattle breeds in Texas and how those breeds have adapted over time to the state's environment. Students will evaluate how both biotic and abiotic factors contribute to changes in gene frequency over time. Additionally, students will identify the advantageous traits of Texas cattle breeds that have contributed to the increase in their population size all while identifying the impact of the Texas cattle industry. This lesson should follow the lesson on expressed traits.

### **Phenomena Focus**

Breeds of cattle will perform poorly in one environment but excel in another.

### **Major Concepts**

- Abiotic factors are the non-living parts of the environment (i.e., air currents, temperatures, light, soil, moisture).
- Biotic factors are the living organisms that inhabit an environment.
- Genetic variation describes naturally occurring genetic differences among individuals of the same species – permits flexibility and survival of a population in the face of changing environmental circumstances.
- Adaptation is any structure, behavior or internal process that enables an organism to respond to stimuli and better survive in an environment.
- Natural selection is a mechanism that explains how populations evolves. Organisms with more favorable variations survive nature's way of weeding out traits that aren't helpful in a certain environment.

- Homeostasis is the regulation of an organism's internal environment to maintain conditions suitable for life.
- Cattle that are better adapted to the climate, grass and other environmental conditions feed better, grow better and reproduce better.
- Cattle whose genetics better match their environment are more effective at utilizing resources.
- Texas is first in the nation for total number of ALL cattle with 13,000,000 cattle (as of May 2019).
- Cash receipts from the sales of cattle and calves in Texas total \$10.5 billion.

## **Objectives**

At the end of this lesson, students will be able to:

- Describe the relationship between environment and adaptations of an animal.
- Evaluate cattle breeds in Texas and explain their adaptive traits, important characteristics as they relate to the environment in the state, and summarize the reproductive selection that has taken place.
- Describe the Texas cattle industry and its impact on the state.

## **TEKS Alignment**

### **Science**

- 112.34.c.7.C: Science concepts. The student knows evolutionary theory is a scientific explanation for the unity and diversity of life. The student is expected to: analyze and evaluate how natural selection produces change in populations, not individuals.
- 112.34.c.7.E: Science concepts. The student knows evolutionary theory is a scientific explanation for the unity and diversity of life. The student is expected to: analyze and evaluate the relationship of natural selection to adaptation and to the development of diversity in and among species.
- 112.34.c.11.B: Science concepts. The student knows that biological systems work to achieve and maintain balance. The student is expected to: describe how events and processes that occur during ecological succession can change populations and species diversity.
- 112.34.c.12.B: Science concepts. The student knows that interdependence and interactions occur within an environmental system. The student is expected to: compare variations and adaptations of organisms in different ecosystems.
- 112.37.c.4: Science concepts. The student knows the relationships of biotic and abiotic factors within habitats, ecosystems, and biomes.
- 112.37.4.H: Science concepts. The student knows the relationships of biotic and abiotic factors within habitats, ecosystems, and biomes. The student is expected to: research and explain the causes of species diversity and predict changes that may occur in an ecosystem if species and genetic diversity is increased or reduced.

### **English Language Arts**

- 110.36.c.1.A: Developing and sustaining foundational language skills: listening, speaking, discussion, and thinking—oral language. The student develops oral language through listening, speaking, and discussion. The student is expected to: engage in meaningful and respectful discourse by listening actively, responding appropriately, and adjusting communication to audiences and purposes.
- 110.36.c.1.B: Developing and sustaining foundational language skills: listening, speaking, discussion, and thinking—oral language. The student develops oral language through listening, speaking, and discussion. The student is expected to: follow and give complex oral instructions to perform specific tasks, answer questions, or solve problems and complex processes.
- 110.36.c.1.D: Developing and sustaining foundational language skills: listening, speaking, discussion, and thinking—oral language. The student develops oral language through listening, speaking, and discussion. The student is expected to: participate collaboratively, building on the ideas of others, contributing relevant information, developing a plan for consensus building, and setting ground rules for decision making.
- 110.36.c.5.E: Response skills: listening, speaking, reading, writing, and thinking using multiple texts. The student responds to an increasingly challenging variety of sources that are read, heard, or viewed. The student is expected to: interact with sources in meaningful ways such as notetaking, annotating, freewriting, or illustrating.
- 110.36.c.5.I: Response skills: listening, speaking, reading, writing, and thinking using multiple texts. The student responds to an increasingly challenging variety of sources that are read, heard, or viewed. The student is expected to: reflect on and adjust responses when valid evidence warrants.

### **Materials/Preparation**

- PowerPoint presentation (prepared by teacher)
- Word Scramble Cards (provided)
  - Print, cut out, and scramble for students to solve
- Copies of breed cards (provided)

## PROCEDURE

### **ENGAGE – Gets the students’ minds focused on the topic**

- *Describe how the teacher will capture students’ interest.*
- *What kind of questions should the students ask themselves after the engagement?*

1. Lead class discussion using the following questions:

- Who can guess how many breeds of cattle there are across the world?
  - *Listen for:* Over 1,000
- Who can guess how many breeds are registered in the U.S.?
  - *Listen for:* Over 75

- What are some breeds you know of in Texas?
  - *Listen for:* Angus, Beefmaster, Brahman, Simmental, Hereford, Brangus, Holstein, and Longhorn
- Why is it that they survive well in Texas? Can we breed for those traits?
  - *Encourage students to think back on last lesson for this answer*
- Do you think some of the breeds here in Texas perform as well in other climates, say in extremely cold climates?

**EXPLORE – Provides students with a common experience; real world connection/personalization**

- *Describe what hands-on/minds-on activities students will be doing.*
- *List “big idea” conceptual questions the teacher will use to encourage and/or focus students’ exploration.*

2. Provide students with the following scenario:

- “You’re a part-time rancher who just came into enough land for 35 head of cattle and you need to decide which breed you want. Review the breed information cards on the table and make your selection. When you picture your ranch, what breed do you envision seeing every morning?”
  - *Teacher note: The goal here is for the students to make an uninformed decision, so that when you are covering the content in the Explain section, they will begin to see how the breed they selected is or is not adapted well to Texas. These breed information cards will include information such as heat tolerance, daily gain, feed requirements, marketability, and other details.*

3. Poll students on their selections. Have a few students volunteer to provide their reasoning behind their selection. The goal is to have a student say something along the lines of “It was pretty,” “I liked the color,” “The horns were cool,” or something that is not based on the characteristics or performance of the animal. When that occurs, provide them with the following analogy:

- “Picture this. You are a competitive race car driver who was just given one million dollars to purchase any new race car because your sponsors want you to win. You have four different options that each have different motors, equipment, and performance. You ultimately decide on the blue one simply because your favorite color is blue. How does that play out for you and your sponsors? Let’s dig in.”

**EXPLAIN – Teaches the concept with interaction between the teacher and students**

- *Student explanations should precede introduction of terms or explanations by the teacher. What questions or techniques will the teacher use to help students connect their exploration to the concept under examination?*
- *List higher order thinking questions which teachers will use to solicit student explanations and help them to justify their explanations.*

4. Open up this section by explaining that we have discovered that picking an animal solely on color or looks is not the best business decision. "As agriculturists, our ultimate priority is the wellbeing and good performance of that animal. To address performance and wellbeing, ranchers pick breeds that are well suited to their local environment."
5. You will now have the students play a word scramble to discover the overarching concepts you'll be explaining in this section.
  - Split students into groups of 3-4, or evenly into nine groups.
  - Each group will be given a sentence to descramble from your materials (see attached word scramble cards). You will need to print these and cut these up prior to class (we recommend placing each cut out sentence in a plastic baggy or clipping them together to keep them from getting mixed up with other sentences.). Those sentences are as follows:
    - Abiotic factors are the non-living parts of the environment (i.e., air currents, temperatures, light, soil, moisture).
    - Biotic factors are the living organisms that inhabit an environment.
    - Genetic variation describes naturally occurring genetic differences among individuals of the same species.
    - Adaptation is any structure, behavior or internal process that enables an organism to respond to stimuli and better survive in an environment over a period of time.
    - Natural selection is a mechanism that explains how populations evolve; breeds or species with more favorable traits and characteristics that fit the environment survive.
    - Homeostasis is the regulation of an organism's internal environment to maintain conditions suitable for life.
    - Cattle that are better adapted to the climate, grass and other environmental conditions feed better, grow better and reproduce better.
    - Texas ranks first in the nation for total number of ALL cattle with 13,000,000 cattle (as of May 2019).
    - Cash receipts from the sales of cattle and calves in Texas total \$10.5 billion.
  - Set the context for the students:
    - a. *"Just like in the lesson where we looked at expressed traits of cattle, we are going to dive deeper into how cattle breeds have adapted to survive in their environment."*
    - b. *At each table (or in each group) is a stack of papers, each having words on it that when put together correctly, make out a definition or fact. On the word "go," as a group, flip over your stack of papers and descramble them as fast as possible. When you are ready to submit your answer, call for me. First team to correctly solve their stack wins! GO."*
  - After they have all finished, have them tape completed sentences on the wall or board.

- You will then use each sentence to guide discussion and provide clarifying information for students. Have students take notes using the sentences as headers and then writing down the important bullet points supporting that sentence.
  - Abiotic factors are the non-living parts of the environment (i.e., air currents, temperatures, light, soil, moisture).
  - Biotic factors are the living organisms that inhabit an environment.
    - Environmental factors (both abiotic and biotic) act as selecting agents of phenotypes.
    - When environmental factors change, different phenotypes will be selected for.
    - As phenotype is largely determined by genotype, successful genotype alleles will increase in frequency in the gene pool.
    - Favorable alleles increase in frequency in a gene pool, while unfavorable alleles decrease.
    - If the frequency of alleles change, evolution is occurring.
  - Genetic variation describes naturally occurring genetic differences among individuals of the same species.
    - Permits flexibility and survival of a population in the face of changing environmental circumstances.
    - Example: A rancher started participating in a cattle program that required them to purchase bulls (males for breeding) from a single breeder. Over time, the rancher noticed that his herd started to demonstrate characteristics that were unfavorable in the market (small sized, small boned, low weights). To fix the problem, the rancher started buying female cows that showed different characteristics (larger size, bigger boned, higher yearling weight) in order to bring more favorable characteristics back into the herd.
  - Adaptation is any structure, behavior or internal process that enables an organism to respond to stimuli and better survive in an environment over a period of time.
    - Example: The large eyes of nocturnal animals allowing them to see in low-light situations
    - Example: How a penguin's feathers are oily; therefore, they don't absorb water and keep the penguin from freezing to death
    - Over time, breeds must adapt to the environment around them or they will die.
      - Example: Through centuries of exposure to inadequate food supplies, insect pests, parasites, diseases and the weather extremes of tropical India, Brahman cattle (native to India) developed some remarkable adaptations for survival.
  - Natural selection is a mechanism that explains how populations evolves. Breeds or species with more favorable traits and characteristics that fit the environment survive.

- This occurs through reproduction.
- This is nature's way of weeding out traits that aren't helpful in a certain environment.
- Those traits are what continue to be passed on to offspring; therefore, weeding out traits that are not favorable to the environment.
- Cattle with lighter colored, short hair coats and dark skin are best adapted to hot climates like that of Texas.
- Animals tolerant to hot climates are less adapted to cold environments and vice versa.
- The Gulf Coast Native sheep has developed a natural resistance to some internal parasites through natural selection. Should the vaccine become unavailable for sheep that don't have this resistance, this breed will be of critical importance to the sheep industry.
- Homeostasis is the regulation of an organism's internal environment to maintain conditions suitable for life.
- Cattle that are better adapted to the climate, grass and other environmental conditions feed better, grow better and reproduce better.
  - When cattle are in environments not suited to them, it causes stress upon their bodies; therefore, they don't perform well in terms of feed conversion, weight gain, and reproduction.
    - High humidity intensifies the effects of heat on cattle. Hot, humid climates often add the stresses of parasites low-forage quality. Heat with humidity stresses cattle that fail to shed long, thick hair coats, particularly dark-colored ones.
  - Cattle whose genetics better match their environment are more effective at utilizing resources (grass, feed, etc.).
  - Breeds with favorable traits to certain environments have been developed over the years via natural selection.
    - Example: New cattle breeds that have been brought into Texas have adapted over time to become better suited to the Texas environment; however, it has taken a number of years for the breeds to evolve.
- Texas ranks first in the nation for total number of ALL cattle with 13,000,000 cattle (as of May 2019). Texas also ranks first in the number of cattle operations and the value of all cattle and calves.
  - More than 13% of the cattle in the U.S. are in Texas.
  - Texas has more cattle than 43 states have people.
  - Because of its diverse climate, many breeds can thrive in the state of Texas. Dominant breeds include: Angus, Beefmaster, Brahman, Simmental, Hereford, Brangus, Holstein, and Longhorn.
  - 97% of Texas cattle farms are family owned.
  - The average person consumes 70 pounds of beef per year.

- Cash receipts from the sales of cattle and calves in Texas total \$10.5 billion.
  - The cattle industry is Texas' No. 1 source of agricultural income
- If time allows, locate and show a video about the Texas cattle industry. An example would include: "Beef's Story – See How Beef Cattle are Raised in Texas" (<https://www.youtube.com/watch?v=MPUd5Gpcr-w>)
  - Instruct students to write down three key facts they learn from the video.
  - Process the video with follow-up discussion questions and ask students to share some of the things they discovered in the video.
  - *NOTE: In this video, he mentions there are 4.5 to 5 million head of cattle in this video. He is referring to strictly beef cattle.*

**ELABORATE** – Provides opportunity for students to apply the concept in a new situation

- *Describe how students will develop a more sophisticated understanding of the concept.*
- *What vocabulary will be introduced and how will it connect to students' observations?*
- *How is this knowledge applied in our daily lives?*

6. Tell students: "Now that we have discovered there is much more to selecting cattle than just color, let's revisit the activity from earlier." Students will draw the traits of the student's local environment (temperatures throughout the year, weather patterns, terrain, grazing availability, etc.) and select cattle that will meet the performance and business expectations of the cattle industry and needs for Texas. Allow students to view the cattle breed cards again to make changes to their earlier selections. Students will be expected to explain their reasoning for their decisions.

**EVALUATE** – Allows students to demonstrate understanding of the concepts and facts

- *How will students demonstrate that they have achieved the lesson objective?*
- *This should be embedded throughout the lesson as well as at the end of the lesson.*

7. Test Question – At the end of class, each student will get a piece of paper and tear it in half. On each piece, the student will write what they believe to be a good test question based off the content they just learned. They will then trade with a classmate and answer the questions written by that classmate. After answering the questions, the papers are traded around once more to be checked for correct answers. If time, the teacher will review the questions and answers out loud.

## SOURCES

- [articles.extension.org](http://articles.extension.org)
- Beef 2 Live-FarmCentric



- University of Arkansas Cooperative Extension Service
- Arkansas Beef Council
- Arkansas Farm Bureau Federation
- Oklahoma State University
- University of Georgia
- Texas Department of Agriculture
- Texas A&M AgriLife Extension Service
- Ranch TV

# ANGUS

- Polled
- Excellent mothers
- Cold tolerant
- High quality carcasses with good marbled meat
- Low birth weight
- High fertility
- Moderate frame size
- Lower growth rate



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# HEREFORD

- Docile
- Easy breeders & calvers
- Low birth weight
- Fast growing calves
- Good mothers
- Low amounts of marbling in meat
- Many are naturally polled
- Heat tolerant & cold tolerant (aka easily adaptable)



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# BRAHMAN

- Originally brought from India
- High growth rate
- Low birth weight
- Poor carcass quality
- Adaptable to adverse environment (i.e., through centuries of exposure to inadequate food supplies, insect pests, parasites, diseases and the weather extremes of tropical India, the native cattle developed some remarkable adaptations for survival)
- General lower carcass quality
- Maximum heterosis in crossbreeding
- Quickly respond to good handling thus becoming very docile
- Heat tolerant
- Black skin
- Good mothers



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# CHAROLAIS

- High growth rate
- Larger frame size
- High milk production
- Horned with polled varieties gaining popularity
- Heavy muscling
- Desirable yield grades
- Excellent meat yield and cutability
- Heat tolerant
- Easy births



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# BRANGUS

- Brahman x Angus cross
- Developed to utilize superior traits of Brahman and Angus (3/8 Brahman and 5/8 Angus)
- Humidity and heat tolerant
- Under cool and cold climate conditions, they produce enough hair for adequate protection
- Good mothers
- Mid-range birth weight
- Polled
- Docile
- Rapid weight gain
- Carcass without excessive fat



# SHORTHORN

- Easy calving
- Low birth weight
- Lower growth rate
- High fertility
- Good mothers
- Moderate frame size
- Polled
- High feed conversion
- Adaptable to adverse environments
- High marbling



# SIMMENTAL

- High growth rate
- Larger frame size
- High milk production
- High fertility
- Calving ease
- Excellent mothers
- Short intervals between calving
- High feed conversion and efficiency
- Both horned and polled varieties available
- Can be used for both meat and dairy production
- Can adapt to the most varied climatic conditions
- Lean beef with high yield





# BEEFMASTER

- 50% Brahman, 25% Hereford, 25% Shorthorn
- Developed to fulfill the following essentials: fertility, milking ability, weight, conformation, hardiness, disposition
- Dual purpose breed meaning they blend strong maternal traits with excellent growth and carcass abilities
- Heat, drought, insect resistant
- High birth weights
- High fertility



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# GELBVIEWH

- Naturally horned (however, naturally polled have been developed in the U.S.)
- High fertility
- Easy calving
- High feed efficiency
- Large frame size
- High milk production
- Docile
- Adapt well to all climates



# MAINE-ANJOU

- Large framed
- High cutability
- High marbling
- Due to large size, can have some calving issues
- Mid-range birth weights
- Easy fattening abilities
- Less likely to become stressed thus resulting in positive gain rates and feed ratios



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# SANTA GERTRUDIS

- 5/8 Shorthorn and 3/8 Brahman
- Adaptable to most climates, environments, and terrains; however, they thrive in hot, humid conditions
- Very disease resistant
- Used in many crossbreeding programs - the resulting crosses yield high levels of hybrid vigor
- Can be naturally horned or polled
- Reach sexual maturity early - begin mating at 12-14 months and have long calving longevity
- High quality carcasses with little waste - dress out percentage of 65%



# TEXAS LONGHORN

- Ability to maintain genetic diversity capable of maximizing hybrid vigor for the population's current needs
- Produces lean meat that's tender and full of flavor
- Very slow growing - 8 to 10 years to reach max weight
- Reproductive period is twice as long as other breeds
- Natural resistance to most common cattle diseases and parasites
- Low birth weights
- Easy calving
- Heat tolerant and cold tolerant



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Abiotic factors are the  
non-living parts of the  
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(i.e., air currents,

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soil moisture.)

Biotic

factors

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Genetic variation

describes

naturally occurring

genetic differences

among individuals

of the same species.



Adaptation is any

structure, behavior,

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Natural selection is a

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Homeostasis is the

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Cattle that are

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and reproduce better.

Texas ranks

1st in the nation

for total number

of all cattle

with 13 million cattle.

(as of May 2019)



Cash

receipts

from the

sales

of cattle

and calves

total

\$10.5 billion.