

“Shackleford Banks Horse Genetics and Evolution”



Photo courtesy of Cape Lookout National Seashore

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Content Areas: Science

NC Essential Standards Science: 7.L.2, 7.L.2.1, 7.L.2.2, 8.L.4, 8.L.4.1, 8.L.4.2

NGSS: MS-LS1-1, MS-LS1-2, MS-LS1-4, MS-LS1-5, MS-LS3-2

Materials:

General (needed for each lesson)

- Computer
- Overhead projector
- Whiteboard

Learning Activity 1

- *Wild ponies of Shackleford Banks* PowerPoint
- Copies of [Vocabulary Preview Graphic Organizer](#) (p. 9)

Learning Activity 2

- *Genetics Mendel and Punnett Square* PowerPoint
- Copies of [Punnett Square Steps Handout](#) (p. 10)
- *Genetics Pedigree Analysis* PowerPoint
- *Genetics Wrap Up* PowerPoint
- Copies of [Punnett Square Worksheet](#) (p. 11)
- Copies of [Horse Pictures](#) (p. 13)

Learning Activity 3

- *Evolution* PowerPoint
- Copies of [Evolution the Game](#) (p. 14), [Evolution Cards](#) (p. 15-16), and [Question Cards](#) (p. 17-18)
- Dice (One for every two students)
- Paper clips and tape
- Colored pencils, markers, or crayons

Activity Time: 60 minutes per activity over 3-4 class periods

Setting: Classroom

Goals and Objectives:

Lesson Essential Question:

- What evidence can be identified within the wild horse community on Shackleford Banks to demonstrate the theory of evolution? (Revisit Essential Question in Activity 3)

Anticipated Outcomes

The student will know:

- The theory of evolution
- That geology, fossils, genetic variation, and comparative anatomy provide evidence of biological and geological evolution
- How organisms are classified
- Within every population, variation exists within the inherited traits of the individuals
- Individual organisms with certain traits (those that are “favored” in the environment) are more likely than others to survive, reproduce and pass these “favorable” traits (such as courting behaviors, coloration or odors in plants and animals, competitive strength) to their offspring
- Within a species, there is a variability of phenotypic traits leading to diversity among the organisms of the species. The greater the diversity, the greater the chances are for that species to survive during environmental changes.
- Know and explain the differences between sexual and asexual reproduction

The student will be able to:

- Explain how biological evolution accounts for the diversity of species developed through gradual processes over many generations.
- Analyze the relationship between genetic variation and an organism’s ability to adapt to its environment.

- Describe how organisms are classified.
- Recognize patterns of heredity from Punnett Squares and Pedigree Analysis
- Construct arguments based on evidence that organisms and landforms change over time

Learning Activity 1: History of Horses on Shackleford Banks Elicit: Vocabulary Preview

- Students will be given this week's set of words (below) and the [Vocab Preview Graphic Organizer](#). Students will classify each new vocabulary word into the column they feel is appropriate for their level of knowledge; teachers will collect to check for prior knowledge.
- **Key Vocabulary to Preview**
 - Adaptation- a change or the process of change by which an organism or species becomes better suited to its environment.
 - Allele- one of two or more alternative forms of a gene that arise by mutation and are found at the same place on a chromosome
 - Anatomy- The body structure of an organism
 - Artificial Selection- Breeding animals to produce desirable traits
 - Blaze- White stripe down a horse's face
 - Biodiversity- The variety of life in a particular habitat or ecosystem
 - Biological Evolution- Any genetic change in a population that is inherited over several generations.
 - Biological Fitness- An individual's reproductive success
 - Chromosome- structure of nucleic acids and protein found in the nucleus of most living cells, carrying genetic information in the form of genes
 - Dam- Female parent of a horse
 - Dominant- A trait that will appear in the offspring if one parent contributes it
 - Favorable Trait- a trait that allows an organism increased survivability and reproductive success
 - Gene- A unit of heredity which is transferred from a parent to offspring and is held to determine some characteristic of the offspring.
 - Genetic Variation- The difference in genes between individual members of a population
 - Genotype- The genetic makeup of an individual organism
 - Heritability- Transmissible from parent to offspring
 - Heterozygous- A pair of alleles where one is dominant and one is recessive
 - Homozygous- A pair of alleles that are the same, they can be either both dominant or both recessive
 - Mutation- A permanent alteration of the genetic makeup of a population
 - Natural Selection- The process whereby organisms better adapted to their environment tend to survive and produce more offspring
 - Phenotype- A set of observable characteristics of an individual
 - Population- A community of animals, plants, or humans among whose members interbreeding occurs

- Recessive- Heritable characteristics controlled by genes that are expressed in offspring only when inherited from both parents
- Sire- Male parent of a horse
- Socks- White leg markings on a horse extending from the hoof up toward the knee
- Star- White marking on a horse's forehead
- Theory of Evolution-The nonrandom survival and reproductive successes of organisms

Explore: Building Background on Wild Horses of Shackleford

- **PowerPoint Presentation, 'Wild Horses of Shackleford'**
 - Use the PowerPoint to introduce the history of the horses.

Evaluate:

- Using a whiteboard in the classroom (or classroom anchor chart), have 4-6 students write a Tweet (140 characters) on the wall about what they find interesting from the presentation. Have 4-6 more students respond to a tweet. Keep up this process for 5-15 minutes or until all students have responded to at least 2 tweets in a thread.

Learning Activity 2: Horse Genetics

Explore:

- **PowerPoint Presentation, "Genetics Mendel and Punnett Square"**
- Print off copies of the *Punnett Square Steps Handout*. This handout has the step by step process of Punnett Squares for the students to refer back to during the worksheet.
- **PowerPoint Presentation, "Genetics Pedigree Analysis"**
 - For younger grades, go through the first six slides. These last two examples are optional if you want to go into more detailed/complex Pedigree Analysis the slides in the last two examples are labeled as Upper Grades.
- Watch *How Mendel's pea plants helped us understand genetics – Hortensia Jimenez Diaz*
- **PowerPoint Presentation, "Genetics Wrap Up"**
- Instructions for Punnett Square Activity
 - Before the class: Print off copies of *Punnett Square Worksheet* and *Horse Pictures*. Print enough of the worksheets and pictures for every four students to have a copy. Have tan, brown, blue and black colored pencils, markers or crayons available for each group. Break the class into groups of four and give each group one worksheet and horse pictures. The students will complete the Punnett Squares in their groups. As they are completing the Punnett Squares each student will pick a block of the Punnett Square to create their horse. Within the groups each student should choose one of the Punnett Square boxes to create a horse. Student one does box one, student two does box two etc., and they should continue to use that box for A-E. The students should keep the same block throughout the worksheet. After finishing all five Punnett Squares each student should have a different completed horse. Have the students compare horses within their groups to see genetic variation within the possible

offspring of the two original horses. Keep the colored horses to be used in the next lesson. (Refer to the worksheet attached below for more information)

1	2
3	4

Evaluate: Collection of Punnett Square worksheet

Learning Activity 3: Evolution of the Horse

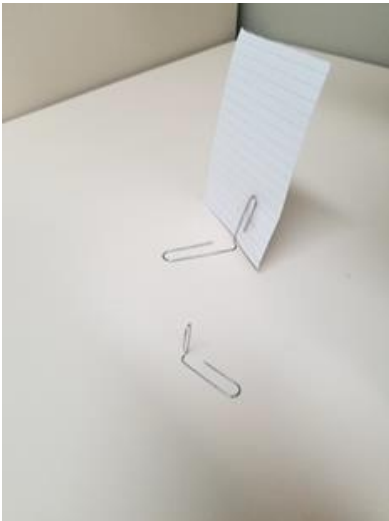
Explore:

- **PowerPoint Presentation, "Evolution"**
- Evolution the Game Instructions
 - Before the class: Print off copies of Evolution the Game, Question Cards, and Evolution Cards. Print enough for every two students to have a copy. Cut out the Question Cards, and Evolution Cards. For more fun print Cards on different colors.
 - Have the students find a partner for this game. Give each pair a printed copy of Evolution the Game, Question Cards, and Evolution Cards. For Game Pieces have students unbend a Paperclip half way and tape it to the horse picture they colored in the last lesson, as shown below. Each game piece represents a horse on Shackleford Banks that needs to evolve to survive. Each player starts at the EVOLVE! square. The player that starts will answer a Question Card read by the other player, if they get it right they will roll the die and move that many spaces, if they get it wrong, they stay in the original square. Then the next player answers a Question Card. Each time a player passes the EVOLVE! square they receive an Evolution Card. As the players move around the board some squares have instructions on them such as; Move back 1 space or Move forward 2 spaces, if the player lands on one of these squares they must follow the instructions. Some squares allow the player to roll again and move forward/backward or answer another question to get the opportunity to roll again. One square makes the player loose an Evolution Card (If a player lands on this square and doesn't have an Evolution Card, then it doesn't affect them). The player with the most Evolution Cards, after all questions have been answered, is the winner.
- Discuss the Essential Question: *What evidence can be used within the wild horse community on Shackleford Banks to demonstrate the theory of evolution?*
 - Teacher notes:
 - Horses that landed on Shackleford Banks would have been accustomed to being fed, provided water, provided shelter, hoof care and solid ground.
 - People like having horses with flashy white faces and legs, however white hair does not protect against sunburn, which could

lead to skin cancer

○ Questions to discuss:

- How might the horses have evolved since landing on Shackleford Banks?
- Would horses with stronger teeth be better able to eat the rough dune and marsh grass throughout their lifetimes?
- Would their digestive systems need to change to allow the horses to switch from eating hay and grain to rough dune and marsh grass?
- Would their phenotype need to include ability to drink less often but in larger quantities to offset the salty grasses?
- Would phenotypes with hooves better adapted to moving on sand and in deep mud have an advantage?
- Would hair coats providing better protection from wet and cold have had an advantage to survive winter?
- Would horses with less white hair have an advantage?
- Would horses that learned faster where to dig to find water have a better chance at surviving?
- Would a herd with greater diversity have a greater chance of survival?



Picture showing how to make the Game Piece

Evaluate: Teacher observation of Evolution Board Game

Extensions: Additional Activities (*Optional*)

- Watch the video *Wild Horses of Shackleford Banks* by: Cape Lookout National Seashore
- What are some of the things you can do to help protect the Wild Horses of Shackleford Banks?
 - Create a poster making people aware of the rules and dangers
 - Make an awareness video
 - Write a poem or song about the history Radio
 - Create a PSA (Public Service Announcement) for TV or
- Hagerman's Fun Fossil Travelling Trunk
 - Available for grade levels 4-6, and 7-12. It includes casts of horse skulls representing a portion of the evolution of horses, geologic samples from the Monument, books, DVDs, and a curriculum guide.
 - For more information or to check out the travelling truck go to <https://www.nps.gov/hafo/learn/education/hagermans-fossil-fun-traveling-trunk.htm>

Vocabulary Preview Graphic Organizer

Write all of this week's words in the box below:

--

Sort each of the words from the box above into the appropriate column below. This should reflect how YOU feel about these words.

The word is completely new to me.	I have heard of the word, but I'm not sure of its meaning	I know the meaning of the word (write the meaning).	I know the meaning and can use it in a sentence (write a sentence using the word.)

Punnett Square Steps Handout

You take the alleles of the sire **Aa** and place them at the top of the Punnett Square.

	A	a

Next take the alleles of the dam **Aa** and place them along the left side of the Punnett Square.

	A	a
A		
a		

Then you fill in the Punnett Square.

	A	a
A	AA	Aa
a	Aa	aa

Remember:

- AA is Homozygous Dominant
- aa is Homozygous Recessive
- Aa is Heterozygous
- The Phenotype for Heterozygous will be the same as Homozygous Dominant.
- Genotype determines Phenotype

Punnett Square Worksheet

Students should individually complete the Punnett Squares for each trait of these two horses:

Sire-AaBbccDdEeFf

Dam-AaBbCcdeeFf

Each letter represents a trait as follows:

A- Chestnut (Tan) Body color

B- Brown mane/tail color

C- Socks

D- Blaze

E- Brown eye color

F- Thick coat

a- Black body color

b- Black mane/tail color

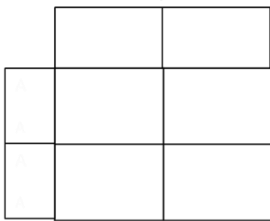
c- No Socks

d- Star

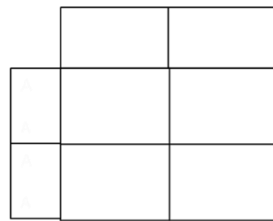
e- Blue eye color

f- Sparse coat

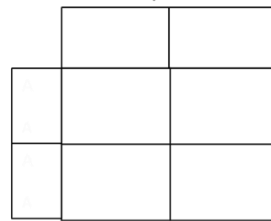
A: Body Color



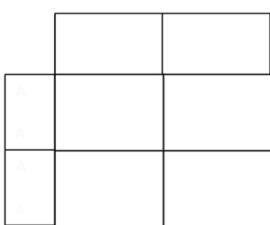
B: Mane and Tail Color



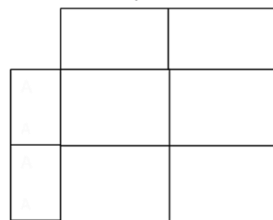
C: Socks/ No Socks



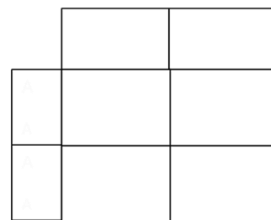
D: Blaze/Star



E: Eye Color

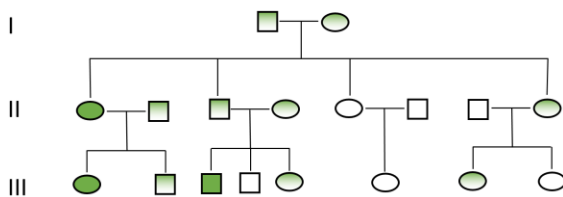


F: Coat Thickness



After completing the Punnett Squares students should get into groups of four. Within the groups each student should choose one of the Punnett Square boxes to create a horse. After the students finish coloring they should compare their horses, and see that everyone within the group has a different horse produced from the same parents.

Bonus:



True/False: Individual II4 is a male, and a carrier for the trait.

True/False: Individual III6 is female, and does not have the trait.

Here is the pedigree analysis for a Maternal Line on Shackleford Banks. If Individual III2 were to mate with a heterozygote, determine what percent of the offspring will have the trait, not have the trait, or be carriers for the trait.

- A. 50% will have the trait and 50% will be carriers.
- B. 50% will not have the trait, and 50% will be carriers.
- C. 25% will have the trait, 25% will not have the trait, and 50% will be carriers.
- D. 50% will have the trait, and 50% will not have the trait.

Punnett Square Worksheet Check sheet

Here are the completed Punnett Squares for the Punnett Square Worksheet, as well as the answer to the bonus question.

A: Body Color

	A	a
A	AA	Aa
A	AA	Aa

B: Mane and Tail Color

	B	b
B	BB	Bb
b	Bb	bb

C: Socks/ No Socks

	c	c
C	Cc	Cc
c	cc	cc

D: Blaze/Star

	D	d
d	Dd	dd
d	dd	dd

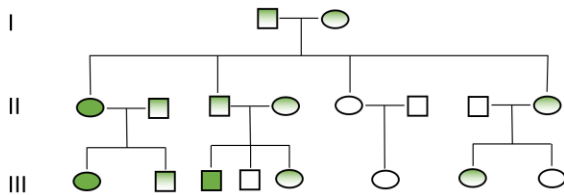
E: Eye Color

	E	e
e	Ee	ee
e	ee	ee

F: Coat Thickness

	F	f
F	FF	Ff
f	Ff	ff

Bonus:



True/False: Individual II4 is a male, and a carrier for the trait.

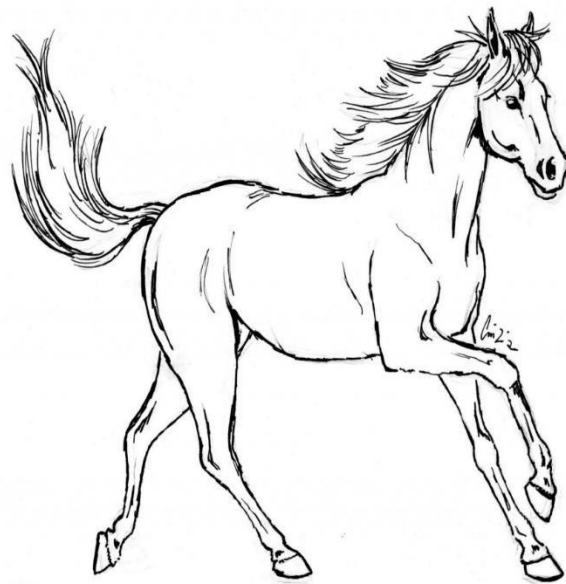
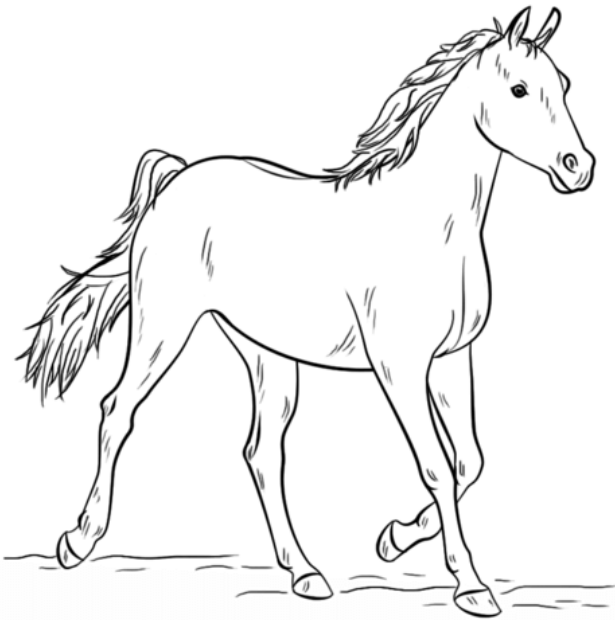
True/False: Individual III6 is female, and does not have the trait.

Here is the pedigree analysis for a Maternal Line on Shackleford Banks. If Individual III2 were to mate with a heterozygote, determine what percent of the offspring will have the trait, not have the trait, or be carriers for the trait.

- A. 50% will have the trait and 50% will be carriers.
- B. 50% will not have the trait, and 50% will be carriers.
- C. **25% will have the trait, 25% will not have the trait, and 50% will be carriers.**
- D. 50% will have the trait, and 50% will not have the trait.

Horse Pictures

Each student should color one picture with their horse's alleles, then use the picture as a Game Piece for a later lesson



Keep Moving!
Roll Again!



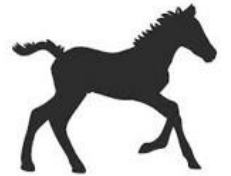
Move
Backward
Two Spaces

EVOLVE!



Move
Forward
Two Spaces

Question Cards



Evolution

Move
Forward
Two Spaces

Move
Forward
One Space



Evolution Cards

Move
Backward
One Space

You got
caught!
Lose an
Evolution Card

Move
Backward
One Space



Answer
Another
Question and
Roll Again!

Evolution Cards

<p>You Evolved! You gained wings!</p>	<p>You Evolved! You gained a third eye!</p>	<p>You Evolved! You gained a horn!</p>
<p>You Evolved! You gained extra legs!</p>	<p>You Evolved! You gained venom!</p>	<p>You Evolved! You gained ability to breathe underwater!</p>
<p>You Evolved! You gained night vision!</p>	<p>You Evolved! You gained ability to glow!</p>	<p>You Evolved! You gained venom resistance!</p>
<p>You Evolved! You gained ability to change color!</p>	<p>You Evolved! You gained ability to climb!</p>	<p>You Evolved! You gained claws!</p>
<p>You Evolved! You gained ability to dislocate Jaw!</p>	<p>You Evolved! You gained arms!</p>	<p>You Evolved! You gained opposable thumbs!</p>

Evolution Cards

<p>You Evolved! You gained a stinger!</p>	<p>You Evolved! You gained pinchers!</p>	<p>You Evolved! You gained ability to spray acid!</p>
<p>You Evolved! You gained super strength!</p>	<p>You Evolved! You gained super speed!</p>	<p>You Evolved! You gained camouflage!</p>
<p>You Evolved! You gained teleportation!</p>	<p>You Evolved! You gained ability to produce your own food!</p>	<p>You Evolved! You gained heat sensing vision!</p>
<p>You Evolved! You gained a <u>beak</u>!</p>	<p>You Evolved! You gained quills!</p>	<p>You Evolved! You gained antlers!</p>
<p>You Evolved! You gained Feathers!</p>	<p>You Evolved! You gained Scales!</p>	<p>You Evolved! You gained Stink Glands!</p>

Question Cards

<p>Q. What is Evolution?</p> <p>A. a permanent change in a population over time</p>	<p>Q. What is a mutation?</p> <p>A. a change in a sequence of genetic material</p>	<p>Q. What Kingdom is the Horse classified in?</p> <p>A. Animalia</p>
<p>Q. What did the middle toe become as the horse evolved?</p> <p>A. The Hoof</p>	<p>Q. What is the name of the first known ancestor of the horse?</p> <p>A. Eohippus</p>	<p>Q. What does diversity increase?</p> <p>A. Survivability of a species.</p>
<p>Q. What is Natural Selection?</p> <p>A. Organisms better adapted to their environment tend to survive and reproduce</p>	<p>Q. What is Artificial Selection?</p> <p>A. The breeding of animals to produce desirable traits</p>	<p>Q. If a species is not diverse name something that may wipe them out?</p> <p>A. Disease, Natural Disaster</p>
<p>Q. Who first thought of the Theory of Evolution?</p> <p>A. Charles Darwin</p>	<p>Q. What animal did Darwin study MOST?</p> <p>A. Finches</p>	<p>Q. What does Common Decent mean?</p> <p>A. All life is descended from one common ancestor.</p>
<p>Q. What is the most specific classification?</p> <p>A. Species</p>	<p>Q. What is the least specific classification?</p> <p>A. Kingdom</p>	<p>Q. When were horses domesticated?</p> <p>A. 3000 B.C.</p>

Question Cards

<p>Q. What is a fact?</p> <p>A. an objective and verifiable observation</p>	<p>Q. What is a theory?</p> <p>A. an explanation of something, based on facts that have been repeatedly confirmed through observation and experiment</p>	<p>Q. What is a hypothesis?</p> <p>A. an idea that you then test</p>
<p>Q. Fossil records show the progression from_____ to very_____organisms.</p> <p>A. Simple to very complex</p>	<p>Q. Organisms that were once_____are now_____.</p> <p>A. Common, Extinct</p>	<p>Q. What is an example of a species that went extinct? (That we went over)</p> <p>A. Horses in the Americas</p>
<p>Q. Organisms today, are_____to fossils found in both young and old rock.</p> <p>A. Similar</p>	<p>Q. What is a mutation?</p> <p>A. A permanent change in a sequence of genetic material of an organism</p>	<p>Q. True or False: Mutations are random.</p> <p>A. True</p>
<p>Q. A mutation could be one of three possibilities. Name them.</p> <p>A. Beneficial, Neutral, or Harmful</p>	<p>Q. Without what could evolution not occur?</p> <p>A. Mutations</p>	<p>Q. What is Adaptation?</p> <p>A. a change or the process of change by which an organism or species becomes better suited to its environment.</p>
<p>Q. What is biodiversity?</p> <p>A. The variety of life in a particular habitat or ecosystem</p>	<p>Q. What is fitness?</p> <p>A. An individual's reproductive success</p>	<p>Q. What is a favorable trait?</p> <p>A. a trait that allows an organism increased survivability and reproductive success</p>