Unit Title: Evolution	**Content Area:** Biology	**Grade Level:** 9-12

Unit Summary: During this unit, students will explore the world as Darwin did on his voyage on the H.M.S. Beagle and investigate what conclusions he came to. They will then apply their understandings as they interpret the pieces of evidence that support the theory of evolution through natural selection. A special focus will be made of the new technology (DNA) available to further support the theory. Finally, the unit will conclude with the students clarifying that evolution by natural selection, environmental changes and/or mutations leads occurs in populations, not individuals.

Science Practices Addressed: Asking questions (for science) and defining problems (for engineering). Developing and using models, Planning, and carrying out investigations, Analyzing and interpreting data, Using mathematics and computational thinking, Constructing, explanations (for science) and designing solutions (for engineering), Engaging in argument from evidence, Obtaining, evaluating, and communicating information

Cross-Cutting Concepts Addressed: Patterns, and Cause and Effect, Stability and Change

Unit Essential Questions:	**Unit Enduring Understandings:**
• How did Darwin's findings support the theory of evolution? • What is "survival of the fittest" and how does it apply to the theory of natural selection? • What evidence did Darwin use to present his case for evolution? How common is genetic variation?	• The theory of evolution (including natural selection and common descent) provide a scientific explanation for the history of life on Earth and are evidenced in the fossil record and in the similarities that exist within the diversity of existing organism. (Specifically: homologous structures, fossil record, geographical distribution, natural selection) • New evidence such as DNA and technology has added to our knowledge and understanding of evolution. • Natural selection, changes in the environment and mutations lead to evolution of populations not individuals. (Specifically: speciation)

Possible Student Misconceptions: The belief that because evolution is called a theory, it has no more likely to be true than any other explanation for biological diversity. Point out that in science theory is a well-tested concept that is supported by evidence. Adaptions are favored and that it guarantees survival.

NJCCCS: 5.3.12.E.1, 5.3.12.E.2, 5.3.12.E.3, 5.3.12.E.4

NGSS Performance Expectations: *Students who demonstrate understanding can…*

- HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
- HS-LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
- HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
- HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

Primary CCSS ELA/Literacy Connections: CCSS.ELA-Literacy.RI.11-12.2, CCSS.ELA-Literacy.RI.11-12.4, CCSS.ELA-Literacy.W.11-12.1, CCSS.ELA-Literacy.W.11-12.4, CCSS.ELA-Literacy.W.11-12.7, CCSS.ELA-Literacy.SL.11-12.1, CCSS.ELA-Literacy.SL.11-12.4	**Primary CCSS Mathematics Connections:** CCSS.Math.Content.HSS.ID.A.1, CCSS.Math.Content.HSS.ID.B.5, CCSS.Math.Content.HSS.ID.C.7

Lesson Pace & Sequence

Lesson Title/Number: Introduction to Evolution	**Learning Objective(s):** Explore the evidence Darwin encountered on his journey and come to conclusions by "traveling like Darwin."	**Lesson Duration:** 80 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the***	***Science and Engineering Practices*** ***What specific practices do students need to use in order***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and***

learning objectives(s)? ****Elements do not have to be in conducted in sequence.***	***mastery of the learning objective(s)?***	***implementation of the learning activities?***	***to progress towards mastery of the learning objective(s)?***	***the learning objective(s)?***	***their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: What do you know about the theory of evolution?				
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Ask students to brainstorm what life was like in the 1800s. Then Read Aloud- History of Science: How Darwin became a naturalist (from the book or an online biography). After reading the text ask, "Where on his journey do you think he will stop?" What do you think Darwin will find on his trip?	• Darwin's Biography: http://www.biography.com/people/charles-darwin-9266433	Obtaining, evaluating, and communicating information	LS4.A: Evidence of Common Ancestry and Diversity	
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Station Activity: Inform students that they will be traveling the world as Darwin did and they will be making similar observations. Stop 1: Brazil- Patterns of Diversity- At this step the teacher will read aloud, "Here, Darwin collected up to 68 different species of beetles in just a single day!" There will be multiple images cut out of different beetle. Ask, "Why do you think there are so many different species in one area? What could lead to this variety? How can so many species coexist? How might we be able to categorize these specimens? How might some stand out? Stop 2: The Galapagos Islands- Students will first be given a map of the Galapagos Islands and asked to write down observations that can be made. The teacher will lead student observation by asking, "Where are the islands located? What	• Darwin's Voyage: http://www.aboutdarwin.com/voyage/voyage01.html	Analyzing and interpreting data Engaging in argument from evidence		Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them

	may the climate be like? What is surrounding them? How close are the islands?" Provide students with images of the different tortoises (or finches) and the corresponding islands they come from. Ask, "Why might there be such variation amongst such close islands? What may keep these tortoises from traveling to other islands? What could have influenced the specific shell shape or neck length?" Stop 3: Africa- Living Organisms and Fossils- Here, they find fossil remains on a table, as well as images of live organisms related to some of the fossils. Ask, "What connections can we make between some of the fossils and live organisms? How are they similar or different? Do you recognize all of the organisms that have been fossilized? What can we learn about species in relation to time by looking at these records?				
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Students will be asked to explain what they learned about by traveling the world in Darwin's shoes. Students will also be asked to refer to their written observations and the specific organism examples. What did Darwin travels reveal to him about the number and variety of living species? How did tortoises differ among the islands of the Galapagos? Darwin found fossils of many organisms that were different from any living species. How would this finding have affected				

	his understanding of life's diversity?				
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Discussion/PPT- Ch. 15-1. Ask students to summarize key point after each subtopic.	• Ch. 15-1	Obtaining, evaluating, and communicating information		Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Exit Quiz: What was so significant about the Galapagos Island? What did Darwin find when he looked at fossils and compared them to living species? What was particularly fascinating about the multiple species found in Brazil by Darwin? Predicting: What traits do you think an animal might need to survive on a hot dry, rocky island? List at least 3 pieces of evidence that Darwin encountered that may support the theory of evolution.		Constructing explanations (for science) and designing solutions (for engineering)		
Extend: How will students deepen their conceptual understanding through use in new context?	Ask, "what do you think Darwin did with his findings once he returned to England?"				
Lesson Title/Number: Introduction to Natural Selection, Lesson 2		**Learning Objective(s):** Explore the concept of natural selection by making observations.			**Lesson Duration:** 80 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core***

***Elements do not have to be in conducted in sequence.**	***objective(s)?***	***activities?***	***of the learning objective(s)?***		***ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: What questions do you think Darwin had when he returned to England after his travels?		Asking questions (for science) and defining problems (for engineering)	LS4.A: Evidence of Common Ancestry and Diversity	
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Provide images of various animals that have some obvious adaptations. Ask, "What characteristics about these organisms aide in its survival? What traits are more desirable? Which may not? What can you tell about their surroundings based on these traits?		Constructing explanations (for science) and designing solutions (for engineering)	LS4.B: Natural Selection	Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Go outdoors to a nearby park (or watch a video with animals from a park) and ask students to make observations in their journals of the types of organisms they encounter, in particular the characteristics they feel are essential for its survival. Some guiding questions include what types of characteristics may have led to the survival of these organisms? Why have these traits existed for generations within these species? What are other characteristics of species outside of what you observed today that may increase the chance of survival?	• Animals in a City Park Video: https://www.youtube.com/watch?v=9J_9GDDYPGA	Constructing explanations (for science) and designing solutions (for engineering) Analyzing and interpreting data		
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Discussion/PPT- Lamarck's Evolution Hypothesis and Introduction to Natural Selection. Have students create a Vern Diagram comparing and contrasting Darwin's and Lamarck's theories.	• Ch. 15-2 & beginning of ch.15-3	Obtaining, evaluating, and communicating information		

Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Students will be provided with two large colorful patterned papers, as well as small and large multi colored butterflies. Some of the butterflies will match the background paper other will stand out. Ask, "predict which butterflies will blend in more, why? What are some characteristics that may influence the survival of the butterflies?" Then ask students to camouflage their butterflies with the provided large backgrounds as best as they can. Have students step away from the board and have them count how many butterflies they see. Then ask, "how does camouflage related to fitness?	• Butterfly Camouflage Activity: http://camillasenior.homestead.com/Camouflaged_-_butterflies.pdf	Planning and carrying out investigations Constructing explanations (for science) and designing solutions (for engineering)		
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Participation, answers to teacher led questions, science journal entries and observations. Section Assessment for Ch. 15-2	• Ch. 15-1, pg. 372.			
Extend: How will students deepen their conceptual understanding through use in new context?	Connecting Concepts: In chapter 5, you learned that both biotic and abiotic factors affect ecosystems. Distinguish between these two factors, give some examples of each, and explain how they might have affected the tortoises that Darwin observed on the Galapagos Islands.		Constructing explanations (for science) and designing solutions (for engineering)		
Lesson Title/Number: Lesson 3: Evidence for Evolution		**Learning Objective(s):** Investigate the multiple pieces of evidence that support the theory of evolution through natural selection.			**Lesson Duration:** 120 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: What is meant but natural selection/survival of the fittest?			LS4.A: Evidence of Common Ancestry and Diversity	
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Select a portion of the book, "On the Origin of Species" by Charles Darwin. Ask, What current areas of scientific research are controversial? How was this book by Darwin controversial in Darwin's time? Guide students to thinking about why Darwin may have taken so long to publish.	• On the Origin of Species PDF: http://www2.hn.psu.edu/faculty/jmanis/darwin/originspecies.pdf	Obtaining, evaluating, and communicating information		Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Jigsaw- Break students into 4 groups (fossil evidence, geographic distribution of living species, homologous body structures, and similarities in embryology) Have each group present notes to the class on each piece of evidence.	• Ch. 15- 3, pg. 382-385			Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Explain: How will you help students connect their exploration to the concept/topic under investigation?	Station Activity: Darwin's Evidence and New Evidence. Have a station for each piece of evidence (fossils, embryology, homologous structures, geographic distribution, and DNA). At each station, students should explore the evidence and write an explanation as to why that it is a supporting evidence for evolution. Be sure to include what Darwin didn't know (DNA evidence).	• ch.15-3	Obtaining, evaluating, and communicating information		
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Writing in science- Write a newspaper article about the meeting in which Darwin's and Wallace's hypothesis were first presented. Explain the theory of evolution by natural selection for an audience who knows nothing about the subject.	• Ch. 15-3, pg. 386	Obtaining, evaluating, and communicating information		
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Section Assessment Ch. 15-3				
Lesson Title/Number: Modeling Adaptation, Lesson 4		**Learning Objective(s):** Use a model to determine how adaptations affect survival of organisms in new habitats.			**Lesson Duration:** 40 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: What is meant by adaptation?				

Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Read, "In this game, three families land on an alien planet. At home, the Hunter family survived by hunting in the cold north. The seeder family famed the temperate zone. The fisher family lived on a tropical island."	• Modeling Adaptation Game, Ch. 15-3, pg. 387		LS4.C: Adaptation	
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Have students read the procedures first then ask, "why do the hunters score the most points in a cold habitat? Why do the Fishers score the least points in a cold habitat?" Begin Procedures to the activity that answer the question, "how do organisms survive in new habitats?" Students will analyze the data found in the textbook to come to conclusions.		Obtaining, evaluating, and communicating information		Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Analyze and Conclude questions.	• Modeling Adaptation Game, Ch. 15-3, pg. 387	Analyzing and interpreting data	LS4.C: Adaptation	Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.
Extend: How will students deepen their conceptual understanding through use in new context?	Applying Concepts: Revise the game to reflect the different conditions of summer and winter. Then, have students demonstrate your game to the class.		Developing and using models		
Lesson Title/Number: Evolution and DNA, Lesson 5		**Learning Objective(s):** Describe how genetics plays a role in evolution by doing inquiry activity.			**Lesson Duration:** 160 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: In what ways are you like your parents? Which traits do you think you inherited?			LS4.A: Evidence of Common Ancestry and Diversity	
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Video- Connecting Genetics with Evolution. Ask students to write discussion questions while they watch the film.	• Mendel and Darwin's Ideas Meet: https://www.youtube.com/watch?v=WhFKPaRnTdQ	Asking questions (for science) and defining problems (for engineering)		
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Inquiry Activity: Does Sexual Reproduction Change Genotype Ratios? Students will be able to calculate genotype ratios in a model population and compare them to Mendelian ratios.	• Ch. 16-1, pg. 392	Using mathematics and computational thinking		
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Discussion/PPT- Evolution of Populations. How common is genetic variation? Help students appreciate how much genetic variation there can be in just one gene. Ask, "How many ABO genotypes are possible? How many genotypes would be possible with four alleles?	• Ch. 16-1	Constructing explanations (for science) and designing solutions (for engineering)		Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Monstrous Mutations Lab- Students will investigate how mutations affect a population by completing lab.	• Monstrous Mutations: http://www.shellysscience spot.com/Worksheets/Evolution/Monstrous%20Mutations.pdf	Planning and carrying out investigations		Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal

					relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Monstrous Mutations- Analyze data and develop conclusions		Analyzing and interpreting data		
Extend: How will students deepen their conceptual understanding through use in new context?	Writing Activity: How does independent assortment relate to genetic variation that results from sexual reproduction? Hint- Refer to Ch. 11	• Ch. 16-1, pg. 396	Obtaining, evaluating, and communicating information		
Lesson Title/Number: Evolution of populations, Lesson 6		**Learning Objective(s):** Explain how natural selection affects single-gene and polygenic traits and how it leads to speciation.			**Lesson Duration:** 160 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Using Visuals: Refer to the table on page 397, "Effect if color mutation on Lizard Survival". Ask students, how does color affect fitness of the lizards? What do you predict the lizard population will look like by generation 50? Explain.	• Ch. 16-2, pg. 397	Constructing explanations (for science) and designing solutions (for engineering	LS4.C: Adaptation	Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

					Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them. Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Demonstration: Show students illustrations of monarch and viceroy butterflies. Challenge them to detect any visible differences between the two species. Explain that monarch butterflies are avoided by bird predators because they taste bitter and that viceroy butterflies are avoided by bird predators because they resemble the bitter tasting monarchs (mimicry). Ask, If monarch butterflies evolved white spots instead of orange spots what do you think would happen to viceroy butterflies?	• Monarch and Viceroy: http://www.learner.org/jnorth/tm/monarch/Viceroy1.html	Obtaining, evaluating, and communicating information		

Explain: How will you help students connect their exploration to the concept/topic under investigation?	Students will read sections of Ch. 16-2 and 16-3 and prepare bullet style notes for their section. They will then teach their peers in front of the class their designated section and provide their peers with the bulleted notes.				
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Analyzing Data: How are these fish related? Students will pretend they are a research team and analyze two different hypotheses about what happened to two different species of fish over time. They will interpret the graphics, compare and contrast, draw conclusions and ask questions regarding the problem.	• Ch. 16-3, pg. 409	Analyzing and interpreting data Constructing explanations (for science) and designing solutions (for engineering		
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Completing chapter 16 study guide.	• Ch. 16, pg. 412-413			
Extend: How will students deepen their conceptual understanding through use in new context?	Integrating Genetic Diversity in Bacteria: Students will be able to observe how antibiotics affect bacterial cultures by answering the lab question, “How common are antibiotic resistant bacteria?". By completing this investigation students are likely to observe limited bacterial growth around the antibiotic disks.	• Ch. 16, pg. 411	Planning and carrying out investigations		