UNIT – CONCEPTS: **GEOLOGIC TIME – Changes in Landforms and Life through Geologic Time**

SUMMARY – The Geologic Time unit is subdivided into two parts: Changes in Landforms through Geologic Time and Changes in Life through Geologic Time. The first part of the unit will guide students through investigative and exploratory activities that explore current evolutionary theories and scientific evidence associated with the origin of Earth: from its core to its crust, its oceans, and its atmosphere. Activities will simulate radiometric dating processes, the correlation of earthquake and volcano data to plate boundaries, and the forces of erosion and deposition. Students will demonstrate their mastery of the concepts addressed in this section by selecting one of Earth's landforms and completing a research project to determine which landforms were created by tectonic or erosion/depositional forces. The second portion of this unit allows students to explore the origin of life on Earth and the evolutionary theories that guide scientists in their interpretation of Earth fossil record. Students will investigate species from Earth's past to develop an understanding of the concepts associated with natural selection and the evolution and extinction of species. A microfossil activity is also included and uses real scientific data from the Ocean Drilling Program (ODP) to assist students in understanding the technology used to obtain ocean sediment cores and their relationship to interpretations of Earth's ancient climates. Students demonstrate their mastery of this portion of the unit by completing a research project to investigate a threatened, endangered, or extinct species.

TARGET AUDIENCE – Middle School Science, English, and Technology

BACKGROUND INFORMATION – This unit provides the initial exposure to Earth's evolution for most students. Many students begin this unit with misconceptions about Earth's origins and age and it is recommended that students be reminded of the legislation designating the separation of church and state. Encourage students to keep an open mind while also encouraging them to maintain their belief system. It is important for students to understand the responsibility of the teacher to complete science objectives established by the state and to maintain a healthy classroom environment that prohibits the discussion of personal beliefs.

LESSON SEQUENCE –

I. Origins of Earth and the Geologic Time Scale
II. Changes in Earth's Landforms over Time
III. Origins of Life and the Geologic Time Scale
IV. Changes in Earth's Life over Time

WEB RESOURCES – The following websites are accessed during this unit:

- http://www.enchantedlearning.com/subjects/astronomy/planets/earth/Continents.shtml
- http://pubs.usgs.gov/gip/dynamic/dynamic.html
- http://www.sciencebuddies.org/mentoring/project_ideas/Geo_p022.shtml
- http://www.worldbook.com/wb/Students?content_spotlight/earth/exploring
- http://neic.usgs.gov/neis/qed/
- http://earthquake.usgs.gov/research/structure/crust/index.php
- http://zebu.uoregon.edu/2002/ph123/lec13.html
- http://park.org/Canada/Museum/extinction/extincmenu.html
- http://pubs.usgs.gov/gip/dynamic/dynamic.html
- http://www.mnh.si.edu/earth/main_frames.html
- http://www.fws.gov/endangered/wildlife.html
- http://animaldiversity.ummz.umich.edu/site/index.html
- http://www.worldwildlife.org/endangered/
- http://www.kidsplanet.org/factsheets/map.html
- http://edtech.kennesaw.edu/web/endangsp.html

LESSON I: Origins of Earth and the Geologic Time Scale

SUMMARY – Students are introduced to geologic time and evidence of Earth's origins while completing a web question "Origins of Earth" in the computer lab. After reviewing the web quest, students create a geologic time scale study guide. The scale is drawn on 9 pages of copy paper on a scale of 1 inch per 50 million years and includes the 4 eons, 4 eras, and 12 periods associated with geologic time. As the unit progresses, students will record illustrations and information specific to each time period on their geologic time study guide. The time line study guide will assist students in visualizing changes in Earth's landforms and life through geologic time.

KEY CONCEPTS –

- Big Bang, Heavy Bombardment, Earth's Layers, Water Cycle, Rock Cycle, Tectonic Cycle, Geologic Time (Eons, Eras, Periods, Epochs), Sediment and Ice Cores

OBJECTIVES – Students will:

- Be introduced to the terms and concepts explored in this unit by using computer skills to complete the web quest "Origins of Earth."
- Calculate a geologic time scale by a ratio of 1 inch to 50 million years.
- Create a geologic time line study guide using information presented during the unit.

MATERIALS –

- "Origins of Earth" Web Quest (in NMS Folder)
- Geologic Time Line Calculations Worksheet
- Geologic Time Line Visual Aids (9-page GTL with measurements; with labels; with illustrations)
- Copy paper (9 pages per student)
- Rulers (1 per student)
- Coloring pencils
- Dynamic Earth Power Point (in NMS Power Points folder)

PROCEDURES –

PRIOR to DAY ONE:

I. Reserve the computer lab for 2 days to allow students ample time to complete the web quest.

II. Students may begin reading Chapter 15, Sections 1 and 5 to assist them in understanding the concept of geologic time.

DAY ONE - THREE: "Origins of Earth"

I. "Origins of Earth" Web Quest – this activity requires 2 computer lab days for completion.

II. Begin Day Three with a review of the content explored in the web quest. Use the web quest to generate class discussion pertaining to:
   a. New information learned in the web quest, including misconceptions
   b. Unusual discoveries (e.g., locations, events, species)
   c. Things you want to learn more about

DAY FOUR - FIVE: Calculating and Drawing the Geologic Time Scale

I. Distribute or Display the **Geologic Time Line Calculations Worksheet** and assist students with calculations for each geologic time period, era, and eon listed on the handout using a ration of 1 inch to 50 million years. (EX: Hadean Eon = 3.8 – 4.5 billion years or 3800 – 4500 million years; => 700 million years long; => 700/50 = 14 inches to represent the Hadean Eon)

II. Distribute the copy paper (9 pages per student) and instruct them as follows:
   a. Orient the pages for "landscape" layout.

b. Number each page from 1 through 9 and remind students to write their names on each page. (Stapling is not recommended at this time but hole-punching will assist students in keeping the papers in their science notebook.)

III. Draw and Label Geologic Time Scale
   a. Draw and Label Eons
      i. Assist students in measuring and drawing the geologic time line, beginning with the Hadean Eon and continuing through the Phanerozoic Eon.
      ii. The eon line should be divided and labeled to differentiate between each eon. Students should record the time in years in parentheses beside each eon.
   b. Draw and Label Eras of the Phanerozoic Eon
      i. Assist students in measuring and drawing the geologic time line, beginning with the Paleozoic Era of the Phanerozoic Eon and continuing through the Cenozoic Era of the Phanerozoic Eon.
      ii. The era line should be divided and labeled to differentiate between each era and appropriate time in years of each era recorded in parentheses.
   c. Draw and Label Periods of the Phanerozoic Eon
      i. Assist students in measuring and drawing the geologic time line, beginning with the Cambrian Period of the Paleozoic Era and continuing through the Quaternary Period of the Cenozoic Era.
      ii. The period line should be divided and labeled to differentiate between each period and appropriate time in years of each period recorded in parentheses.

PROCEDURES for ASSESSMENT – Options for assessment of this lesson are listed below:
1 – Web Quest completion and discussion
2 – Geologic Time Worksheet Calculations
3 – Geologic Time Line Construction

LESSON II: Changes in Earth's Landforms over Time

SUMMARY – Students will explore changes in the Earth's landforms throughout geologic time, beginning with the Hadean Eon and progressing through the Phanerozoic Eon. Tectonic and erosion processes that have changed Earth's surface through time will also be explored using class discussions and lab activities that will assist students in understanding their impact to Earth.

KEY CONCEPTS –

- Uniformitarianism, Catastrophism, Erosion/Depositional Forces, Tectonic Forces, Real-time Data of Earthquakes/Volcanoes, Landforms Shaped by Erosion/Deposition/Tectonics

OBJECTIVES – Students will:

- Describe examples of uniformitarianism and catastrophism.
- Illustrate changes occurring on Earth during the Hadean, Archean, Proterozoic, and Phanerozoic Eons.
- Illustrate the origin of the Water Cycle, Rock Cycle, and Tectonic Cycle.
- Illustrate concepts associated with Plate Tectonics and Continental Drift, including rock and fossil evidence, and plate boundary movements.
- Map real-time earthquake and volcano data to identify the worldwide distribution of earthquakes and volcanoes.
- Investigate the formation and geologic time frame of Earth's landforms.

MATERIALS –

- Chapter 15 (Holt, Rhinehart, Winston)
- Dynamic Earth Power Point
- LAB: Worldwide Distribution of Earthquakes and Volcanoes
- RUBRIC: Changes in Landforms throughout Geologic Time
- Presentation Table: Changes in Landforms over Time
- SCIENCE TEST: Understanding Changes in Landforms over Time

PROCEDURES –

PRIOR to DAY ONE:

I. Review Chapter 15, Section 1 to be sure students have an understanding of uniformitarianism and catastrophism. These two principles of interpreting Earth's past are covered in this section.
II. Encourage students to add color to their time line as they continue to add illustrations throughout the unit.

DAY ONE: Use the Dynamic Earth Power Point to guide students through each eon of geologic time.

I. Hadean Eon – assist students with illustrations and labeling for each of the following:
    a. Prior to Hadean – The Big Bang
    b. Heavy Bombardment
    c. Layering of Earth based on Density
    d. Elements Found in Earth's Crust (record the most abundant elements)

II. The technology used to make these interpretations
    a. Crust – Sediment and Rock Cores
    b. Mantle to the Core – Measurement and Calculations using Seismic Waves
        I. Man-made seismic waves generated to measure and calculate
        II. Natural events – earthquakes – also measured and calculated

DAY TWO through FOUR (depending on the mode of inquiry for Erosion/Deposition):

I. Archean Eon
    a. Water Cycle Begins, including weather
        i. Assist students with illustrations of the water cycle
        ii. Use the illustration to review the water cycle (from 7th grade) and its role in forming Earth's ocean and creating new landforms

b. Rock Cycle Begins
    i. Assist students with illustrations of the rock cycle
    ii. Use the illustration to review the rock cycle (from 6th grade) and its role in changing Earth's landforms over time through erosion and deposition
c. Erosion and Deposition Begins – assist students in recording the erosion/deposition table on their time line
d. Agents of Erosion Table
    1. Running Water – the agent is the primary force of change in Earth's surface
    2. Glaciers – this agent occurred in later eons
    3. Wind
    4. Waves
    5. Gravity
e. (DAY FOUR) DEMONSTRATION and INQUIRY (choose from the following)
    1. Complete sample demonstrations of the various types of erosion
    2. Show animations from the CLASSZONE website to illustrate different types of erosion
    3. Provide classroom stations where students can work in pairs or small teams to explore each type of erosion (outdoor classroom is recommended for this option)
f. Land above Sea Level Forms
g. Origin of Life (extremophiles, cyanobacteria) – these will be explored in more detail in the 2nd portion of this unit and should only be mentioned briefly at this time
h. Origin of Photosynthesis – review the chemical formula and cycle associated with photosynthesis and review (from 6th grade) its role in changing Earth's atmosphere

DAY FIVE:

I. Proterozoic Eon – assist students with illustrations and information based on the following:
    a. Rodinia – Earth's first continent
    b. Atmosphere to support more life
    c. Late Proterozoic = Snowball Earth
II. Phanerozoic Eon
    a. Landmasses increase to form Pangaea
    b. Earth's major landforms were created by tectonic forces during this eon
    c. Erosion begins shaping many of Earth's landforms
    d. Late Phanerozoic characterized by intermittent Ice Ages and global warming
III. Review the changes in the 4 eons of Earth's geologic time

DAY SIX and SEVEN: The evidence supporting these changes

I. Theory of Continental Drift:
    a. Rock Evidence
        i. Matching mountain ranges
        ii. Matching coal deposits
        iii. Matching glacier deposits
    b. Fossil Evidence across Gonwandaland
        i. Glossopteris plants
        ii. Mesosaurus
        iii. Cynognathus
        iv. Lystrosaurus
II. Sea-floor Spreading:
    i. Rocks match in ages on each side of a spreading ridge
    ii. Magnetic alignment matches on each side of the spreading ridge
    iii. Rocks are younger near the mid-ocean ridges and older as your progress away from the ridges across the seafloor
    iv. Longest mountain range in the world (over 36,000 miles long)
    v. Knowledge of seafloor spreading led to a new theory: Plate Tectonics

DAY EIGHT AND NINE:

I. INQUIRY LAB: Locating the Worldwide Distribution of Earthquakes and Volcanoes
(See Lab Activity Directions for Procedures and Follow-up)

II. Use the completed Earthquake/Volcano Maps in a class discussion. Be sure to include the following:
   a. Distribution of earthquakes and volcanoes (random or concentrated)
   b. Correlation between plate boundaries and plots – Use Plate Tectonics map with plate boundaries to illustrate correlation between E/V Data and boundary locations.
   c. Historical perspective for this type of data

DAY TEN and ELEVEN:

I. The Theory of Plate Tectonics – (continue with Power Point Presentation and assist students with note taking using tables and illustrations to organize the different types of boundaries and collisions)
   d. Earthquake and Volcano Data – use USGS website to demonstrate real-time data used to monitor data
   e. Plates driven by convection currents
   c. Earth's Lithosphere Plates (7 major, 9 minor)
   d. Plate Boundaries
      i. Divergent boundaries form at mid-ocean ridges formed where seafloor spreading is pushing the plates apart
      ii. Convergent boundaries form along collision zones
         1. Subduction zones form
         2. 3 types of collisions determined by plate type
            a. Continental vs. Continental Convergence
               i. Large mountains form
               ii. Continental plates are less dense and rise upward
            b. Oceanic vs. Continental Convergence
               i. Denser oceanic plates is subducted
               ii. Trenches form on the seafloor
               iii. Less dense continental plate is pushed upward
               iv. Melting plate in subduction zone fuels volcanic activity
               v. Volcanic mountains form
            c. Oceanic vs. Oceanic Convergence
               i. Older, denser oceanic plate is subducted
               ii. Trenches form on the seafloor
               iii. Younger oceanic plate pushes upward
               iv. Volcanic island arcs form
      iii. Transform or Strike-slip form where plates grind past each other

DAY TWELVE through SIXTEEN – Be sure to reserve the media center for a couple of days of research. Afterwards, spend some time in class helping students organize their notes and creating a PPT storyboard. Next, reserve the computer lab for a couple of days for students to organize and practice their Power Point Presentation of their project.

I. PROJECT-BASED INVESTIGATION – Changes in Landforms over Time
   a. Display choices of landforms and assist students in selecting one landform to investigate
   b. Instruct students to use their notes to assist them in determining the forces that shaped their landform:
      i. Tectonics
      ii. Erosion/Deposition

c. Provide students with 2 days in the media center, using books and the Internet, to locate information from the Rubric for their landform.
d. Provide students 1 class day and homework assignment to complete their PPT storyboard for their landform presentation. Be sure students are following the rubric.
e. Provide students with 2 class days to complete and practice their PPT presentation for their landform.

II. ORAL PRESENTATIONS of Changing Landforms over Time
a. Distribute Changing Landforms over Time Table and instruct students to complete the table as each landform is presented during class.
b. Encourage students (audience) to ask questions after each presentation to be sure information on the table is complete.
c. Students should use their completed table, geologic time line, and notes from class to prepare for the science test.

PROCEDURES for ASSESSMENT - Each or all of the following may be assessed for scoring:
I. Accuracy of the Geologic Time Line
II. LAB: Worldwide Distribution of Earthquakes and Volcanoes
a. World Map of Data
b. Written Lab Report using the Lab Rubric
III. Changing Landforms over Time PPT Presentation using Presentation Rubric
IV. SCIENCE TEST: Understanding Changes in Landforms over Time

(OPTION: Follow-up this unit with the activity: Microfossils in Blake's Nose. This activity provides students an opportunity to reinforce their knowledge of the Earth's geologic time chart and plate tectonics as they access real-time data from the International Ocean Drilling Program's database. Students will investigate microfossils and learn how scientists make interpretations about Earth's ancient climates based on the various species distribution stored in ocean sediment cores.)

LESSON III: Origins of Life and the Geologic Time Scale

SUMMARY – Students will build upon prior knowledge of the geologic time scale to develop an understanding of the changes in life throughout Earth's geologic history, beginning with the Hadean Eon and progressing through the Phanerozoic Eon. Current theories describing the origins and progression of life will be explored. A hands-on investigation will be completed to demonstrate the diversity of life generated via meiosis and mutations. Students will record major advances in cellular biology and record mass extinction events along the geologic time line.

KEY CONCEPTS –

- Uniformitarianism, Catastrophism, Primordial Soup, Amino acids, Prokaryotes, Eukaryotes, Binary fission, Mitosis, Meiosis, Mutation, Adaptation

OBJECTIVES – Students will:

- Correlate changes in Earth's geology with the advancement of life on Earth.
- Illustrate cellular changes in organisms over time.
- Identify time periods in which mass extinction events are recorded in the rock and fossil record.
- Demonstrate the role of meiosis in the diversity of Earth's life and species.

MATERIALS –

- Science Textbook, Chapters 11, 12, 15, and pages 542 – 544
- 9-page Geologic Time Line
- Web quest of Living Organisms (optional)
- LAB: Reebop Activity
- SCIENCE TEST: Understanding Changes in Life throughout Earth's Geologic Time

PROCEDURES –

PRIOR to DAY ONE:

I. Reserve the media center or computer lab for Day 8 through Day 10 to provide ample time for students to complete their research investigation of Endangered Species.

II. View "Origins of Earth" DVD – This video provides a review of the four eons of geologic time and also introduces students to the changes in life forms from the Archaean to the Cambrian Explosion. (This video may be used as an introduction to this segment of the unit or as a review at the end of this segment.)

DAY ONE through FIVE: **Life on Earth** – Use the 9-page geologic time scale to add diagrams and notes of Earth's life forms throughout the four eons of time.

III. Adding Life to Earth's Geologic Time Scale

a. Hadean – no record of life on Earth during the Hadean Eon

b. Archaean – 1st fossil record of life on Earth = single-celled prokaryotes (bacteria without a nucleus; still contain DNA)

i. Extremophiles – The discovery in 1970s of thermophiles living inside hydrothermal vents is changing scientists' thoughts on the origin of life on Earth. Extremophiles use chemosynthesis – converting chemicals to energy.

ii. Cyanobacteria – The oldest known fossil record on life on Earth dates to 3.8 billion years ago. Cyanobacteria use photosynthesis – converting light to energy. Cyanobacteria receive the credit for pumping enormous volumes of oxygen into Earth's atmosphere through photosynthesis, forming Stromatolites.

iii. Archaean life currently thought to be limited to prokaryotes (add examples of prokaryotes present during Archaean)

c. Proterozoic Life

i. Eukaryotes appear 1.8 BYA (bacteria with a nucleus)

ii. Multi-cellular life begins in the Proterozoic – multi-cellular algae (middle Proterozoic); multi-cellular animals (late Proterozoic)
iii. Binary fission vs. Mitosis vs. Meiosis

d. Phanerozoic Life
i. LAB: Reebop Activity: How meiosis leads to diversity of life forms
ii. Cambrian Explosion
1. Life moves from sea to land - land plants and animals
2. Coal forests
3. Age of Reptiles
4. Age of Mammals
5. Origin of Humanity
iii. **Five Major Extinctions** – Use Geologic Time Chart Poster to assist in this discussion
1. Ordovician Extinction (440 MYA) >50% of the species known in the Ordovician Period disappear.
2. Devonian Extinction (365 MYA) >50% of the species known in the Devonian Period disappear.
3. Permian Extinction – (225 MYA) 95% of marine and 70% of land species shown in the Paleozoic fossil record disappear; *largest mass extinction currently recorded.*
4. Triassic Extinction (210 MYA) 75% of species shown in the Triassic fossil record disappear.
5. KT Extinction – (65 MYA) >50% of species shown in the Mesozoic fossil record disappear; layer of iridium-rich rock layers followed by volcanic ash layers fuels asteroid impact theory, followed by immense volcanism on Earth.
6. Other minor extinction events are also recorded in the fossil record with extinction rates <50% of the known species.

PROCEDURES for ASSESSMENT - Each or all of the following may be assessed for scoring:
I. Accuracy of the Geologic Time Line
II. SCIENCE TEST: Understanding Changes in Life throughout Earth's Geologic Time

LESSON IV: Changes in Earth's Life over Time

SUMMARY – Students will explore the historical framework of evolution theory, including anatomical, embryological, and molecular/chemical studies. Students will also investigate the principles that support natural selection and how current technologies (e.g., genome research) and refining our current evolutionary theories. Students will complete inquiry activities and a research investigation of an endangered species to demonstrate their knowledge of evolutionary concepts within our changing environment.

KEY CONCEPTS –

- Natural Selection, DNA/Genome, Homologous Structures, Mutations, Speciation, Co-evolution, Endangered Species, Extinction, Adaptation, Uniformitarianism, Catastrophism

OBJECTIVES – Students will:

- Compare and contrast the historical aspects of anatomical, embryological, and molecular evidence to support changes in organisms over time.
- Describe early evolutionary theories, including Jean-Baptiste de LaMarck's ideas of "use and disuse" and the "inheritance of acquired characteristics."
- Describe how Darwin's ideas of overproduction and variation in species assist in defining natural selection.
- View "Voyage to the Galapagos" and observe examples of evolution and scientific studies being conducted on the endemic species of the Galapagos Islands.
- Compare and contrast physical, physiological, and behavioral adaptations that promote survival in plant and animal species.
- Explore the affects of environmental influences and isolation upon speciation.
- Investigate a threatened, endangered, or extinct species to determine the adaptations necessary for survival and the risks associated with endangered species and present their findings to the class.

MATERIALS –

- Science Textbook, pages 542 – 544
- Computers with Internet access
- Endangered Species Rubric
- Tri-fold Foldable for Evidence of Change notes
- DVD – "Voyage to the Galapagos" (and video worksheet)
- Anatomical, Embryological, and Molecular Evolution images
- LAB: Diarmis Proboscis Activity
- Evolution of Species over Time PPT Presentation
- Sperm Whale PPT Presentation
- Manatee PPT Presentation
- Manatee Science Test

PROCEDURES –

PRIOR to DAY ONE: Reserve the media center or computer lab for Day 9 through Day 12 to provide ample time for students to complete their research investigation of Endangered Species.

DAY ONE and TWO: SURVIVAL 101: Good Genes or Bad Luck??

I. INQUIRY LAB: Diarmis Proboscis – (This lab may be used to begin this portion of the unit as a total inquiry activity to help students discover natural selection or it may be used after the natural selection content has been reviewed to reinforce the concepts of variation and survival of the fittest.)
   a. (LAB MODIFICATION: Have students draw cards with the following labels:
      i. Feed using either hand
      ii. Feed using left hand only with right hand in your pocket
      iii. Feed using left hand only with right arm tied to your right leg
   b. Distribute lab worksheet and review procedures with students before escorting them outside for the activity. Follow activity procedures to complete the lab.

c. Lead a class Discussion after recording the data for the class, including the following:
    i. Which variation in the species survived?
    ii. Which variation in the species died out?
    iii. Which variation survived to reproduce more offspring?
    iv. How is DNA affected by natural selection?
d. OPTIONAL: After discussing the data set, tell the class that one type of feed was tainted with harmful pesticide chemicals and causes birth defects in the offspring. Poll student results to see which D. Proboscis' ingested the most harmful seeds. Discuss outcomes for the species based on the results.

DAY THREE and FOUR: Use the Evolution of Species PPT to guide students' note taking for this section.

II. **Early Ideas of Evolution**
a. **Jean-Baptiste de LaMarck** – Two guiding principles:
    i. Use and Disuse – the more a body part is used the stronger, more developed it becomes
    ii. Inheritance of acquired characteristics – once a new characteristic is developed, it will be passed to the offspring
    iii. LaMarck used these guiding principles to explain how birds developed the ability to fly.
    iv. LaMarck didn't believe species went extinct but that they evolved from a simple to a more complex form (remnants of earlier "spontaneous generation" theories.
b. **Natural Selection** ("Survival of the Fittest") – developed by **Charles Darwin** in the 1800s. Two Guiding Principles:
    i. Variation – in the species can assist in survival
        1. Peppered Moths Example
        2. Pre-Industrial Revolution
        3. Post-Industrial Revolution
        4. Post EPA (Environmental Protection Agency)
        5. Darwin's Finches
            a. 13 species of finches adapted to the available food for its given location
            b. Beak-designs based on type of food eaten by each type of finch
        6. Diarmis Proboscis Example
            a. Which variation of "seed" survived best? (usually green and yellow because their color variation blended in with their surroundings)
            b. Adaptations, such as camouflage, aid survival of a species
    ii. Overproduction – of offspring can assist survival
        1. Producing more offspring to increase chances of survival in the species
        2. Examples – sea turtles, spiders, fish

DAY FIVE and SIX: Observing Natural Selection

I. **"Voyage to the Galapagos"** – DVD (view over 2 class periods)
a. Distribute "Voyage to the Galapagos" worksheet
b. Introduce the key concepts illustrated in the video
    i. Charles Darwin's 5-year voyage on board *The Beagle* as a naturalist, collecting specimens of plants and animals around the world.
    ii. Observe how different species are affected by their environment:
        3. Food
        4. Climate
        5. Predators

c. Discuss student observations from the video and assist students in completing the video worksheet. Revisit the original question: How is DNA affected by natural selection?

DAY SEVEN:

II. **Historical Perspective for Evolutionary Theories** supporting descendents from a common ancestor.
   a. Anatomical Evidence – based on homologous structures
      i. Different organisms have similar anatomical features that serve similar functions
      ii. LaMarck and Darwin used this type of evidence to support their theories
      iii. Evidence available during the 1700s through today; influenced by societal views
      iv. Mendel's Heredity Studies had not yet occurred when LaMarck and Darwin were publishing their theories
   b. Embryological Evidence – based on comparisons of embryos of different organisms, including humans
      i. Embryos of very different organisms look very similar during early stages of embryonic development
      ii. Darwin used embryological evidence to develop his theory
   c. Molecular/Chemical Evidence – based on comparisons of proteins and DNA/genome of different organisms
      i. More closely matched the DNA code is, the more closely related the species are
      ii. Humans and chimpanzees match at 98%
      iii. Molecular studies began in the 1960s
      iv. DNA Sequencing studies available since the 1980s
      v. Allen Wilson (UC-Berkeley) compared the DNA of the quagga to the zebra (also 98% match) to determine that the 2 species share a common ancestor
   d. TIMELINE of EVOLUTION THEORIES

Pre-1800s	**early 1800s**	**1801**	**1859**	**1860**	**1960**	**1980**
Spontaneous Generation	Embryological Evolution Studies	LaMarck's Theory	Darwin's Theory	Mendel's Peas	Molecular Evolution Studies	DNA Sequencing

DAY EIGHT:

III. Adaptations in Species – How are species adapted to survive their environment? Assist students in constructing a table to illustrate and describe the following types of adaptations to survival:
   a. Physical Adaptations
   b. Behavioral Adaptations
   c. Physiological Adaptations

IV. Review the Endangered Species Rubric and model the project investigation using the Sperm Whale PPT.

DAY NINE through TWELVE: COMPUTER LAB (Reserve the computer lab, or media center, for 4 days of computer research and PPT design.)

V. **PROJECT-BASED INVESTIGATION** - Threatened, Endangered, or Extinct? (T525)
   a. Select a species of plant or animal and locate the following information to organize into a PowerPoint presentation for the class
      i. Is the species you selected threatened, endangered, or extinct?
      ii. Where does your species live: distribution area, habitat, niche?
      iii. What adaptations allow your species to survive?
         1. Physical adaptations
         2. Behavioral adaptations

3. Physiological adaptations
   iv. What threatens or endangers the survival of your species?

b. Project Modeling – Use the Sperm Whale Presentation to model a completed project to the class.

c. POWER POINT DESIGN: Locate pictures to illustrate your findings, including:
   i. Pictures of your species' niche?
   ii. A map showing the distribution of your species
   iii. Illustrate the physical adaptations your species has acquired to encourage survival (teeth, claws, tail, fins, etc.)
   iv. Illustrate the behavioral adaptations your species has acquired to encourage survival (eating or survival skills, life cycle, etc.)
   v. Illustrate the physiological adaptations your species has acquired to encourage survival (changes in water or air pressure, metabolism, gills, breath-holding, etc.)
   vi. Illustrate the factors that threaten or endanger the survival of your species (deforestation, development, over-fishing, etc.)
   vii. List resources, using a MLA bibliography format, where you obtained your images and information.

d. Things to consider in your PowerPoint presentation.
   i. Use pictures that illustrate your findings
   ii. Use words ONLY to label pictures, if needed. Do not type sentences of information on your slides.
   iii. Organize your slides for a 5-minute presentation (maximum)
   iv. Use a bibliography page at the end to cite your resources

DAY THIRTEEN and FOURTEEN: ORAL PRESENTATIONS of Species Adaptations
I. Distribute Endangered Species Presentation Table Worksheet and advise students to complete the information as it is presented for each species.
II. Review the worksheet after completing the presentations to determine common variables noted throughout the presentations
   a. Loss of habitat
   b. Over harvesting (fishing, hunting)
   c. Similarities
   d. Long term impact

DAY FIFTEEN through SIXTEEN: SCIENCE TEST REVIEW
I. The Plight of the Manatee – Use the PPT presentation and guide students with note-taking. This presentation is designed as a review for the SCIENCE TEST.
II. SCIENCE TEST: Understanding Changes in Life through Geologic Time; Changes in Species-Manatee

PROCEDURES for ASSESSMENT – The following may be used to assess student mastery of the concepts explored in this lesson:
I. Geologic Time Chart completion, including land and life
II. LAB: Dhiarmis Proboscis Worksheet
III. "Voyage to the Galapagos" Worksheet
IV. PROJECT: Adaptations of Species
V. SCIENCE TEST: Understanding Adaptations in Species: The Manatee

WORKSHEETS USED IN GEOLOGIC TIME UNIT

I. Geologic Time Chart Calculations

Geologic Time	Millions of Years Ago (MYA)	Range in years	Years in Inches
Hadean Eon	4500 – 3800	700	14
Archean Eon	3800 – 2500	1300	26
Proterozoic Eon	2500 – 543	1957	39
Phanerozoic Eon	543 – today	543	10.8
Paleozoic Era	543 – 248	295	6
Cambrian Period	543 – 490	53	1
Ordovician Period	490 – 443	47	1
Silurian Period	443 – 417	26	.5
Devonian Period	417 – 354	63	1.3
Mississippian Period	354 – 323	31	.6
Pennsylvanian Period	323 – 290	33	.7
Permian Period	290 – 248	42	.8
Mesozoic Era	248 – 65	183	3.7
Triassic Period	248 – 206	42	.8
Jurassic Period	206 – 144	62	1.2
Cretaceous Period	144 – 65	79	1.6
Cenozoic Era	65 – today	65	1.3
Tertiary Period	65 – 1.8	63	1.3
Quaternary Period	1.8 - today	1.8	1/25th of an inch*

* Place mark between the 1/32th mark and the 1/16th mark on your ruler.

II. LAB: Worldwide Distribution of Earthquake/Volcano Activity
III. RUBRIC: Changes in Earth's Landforms over Time
IV. PRESENTATION TABLE: Changes in Earth's Landforms over Time
V. SCIENCE TEST: Understanding Changes in Landforms over Time
VI. "Voyage to Galapagos" DVD Worksheet
VII. LAB: Dhiarmis Proboscis Lab Sheet
VIII. WEB QUEST: "Living Organisms" Web Quest
VIX: PRESENTATION TABLE: Adaptations of Species
X. LAB: Reebop Activity
XI. SCIENCE TEST: Understanding Changes in Life through Geologic Time
XII. SCIENCE TEST: Changes in Species - Manatee

Ideas: (investigation of organisms through time… make cards with names, geologic time period, size, picture, type of organism)
(Students arrange in correct chronological order of evolution)
PETM Event – Global Warming Without a Human Catalyst

VII. LAB: Dhiarmis Proboscis Lab Sheet *(This activity is adapted from the original activity published by Jocelyn Young in the NSTA Science Scope Journal, January 2005.)*

QUESTION: How do adaptations help a species to survive its environment?

HYPOTHESIS:

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BACKGROUND INFORMATION: You are *Diarmis Proboscis*, which is a type of docile and flightless bird species that has evolved 2 long appendages that are used to feed on their favorite prey (*Wormis Toothpickus*). The knees of *Diarmis Proboscis* can bend slightly; therefore, the keenness of sight must distinguish the one and only type of food that is necessary for survival. *Wormis Toothpickus* comes in a variety of colors but is relatively uniform in shape. *Wormis Toothpickus* are found in, around, and on top of grass and there are a number of these just outside the classroom.

TESTING YOUR HYPOTHESIS:
Materials/Equipment:
Four hundred (400) Toothpicks (100 blue, 100 green, 100 red, 100 yellow) have been placed in a small feeding area outside the classroom.

Procedures:
A flock of *Diarmis Proboscis* will feed during 1-minute intervals to collect 10 *Wormis Toothpickus*. *D. Proboscis's* that collect 10 *W. Toothpickus* in the first feeding interval will survive to participate in the additional 1-minute feeding intervals until they can no longer collect 10 *W. Toothpickus*. *Diarmis Proboscis's*, which are not able to collect 10 *W. Toothpickus* during each feeding interval, will "die out" and remain seated away from the feeding area until all of the *W. Toothpickus* have been consumed. After feeding, store your *W. Toothpickus* in the plastic bag provided. When all of the feeding sessions are completed, return to the classroom with your *W. Toothpickus.*

ANALYZE YOUR RESULTS:
1 - Complete the data table below:

COLOR	Your # Captured	Class # Captured	Total # Outside	% Captured (Class)	% NOT Captured (Class)
RED			100		
YELLOW			100		
GREEN			100		
BLUE			100		

2 – Using graph paper, construct a graph that shows "Your # Captured" for each color of *W. Toothpickus*.

3 – Using the same sheet of graph paper, construct a second graph that shows the "Class # Captured" for each color of *W. Toothpickus.*

4 – Using a different sheet of graph paper, construct a third graph that shows the "% Captured by the Class" for each color of *W. Toothpickus.*

CONCLUSION: (Answer the following questions to help you in determining your findings.)
1 – What are some of the adaptations that *D. Proboscis* had to make in order to feed on the *W. Toothpickus*? Why?

2 – How efficiently did *D. Proboscis* capture its prey? (HINT: Look at the data table for numbers captured (class) versus the total number outside.)

3 – What would probably happen to *W. Toothpickus* if *D. Proboscis* became extinct?

4 – What would probably happen to *D. Proboscis* if *W. Toothpickus* became extinct?

5 – If you wanted to change something on *D. Proboscis* to help it feed more efficiently, what would that change be? Why?

6 – If you wanted to change something on *W. Toothpickus* to help it avoid being eaten, what would that change be? Why?

7 – How did your numbers of captured *W. Toothpickus* compare with the class data? Why?