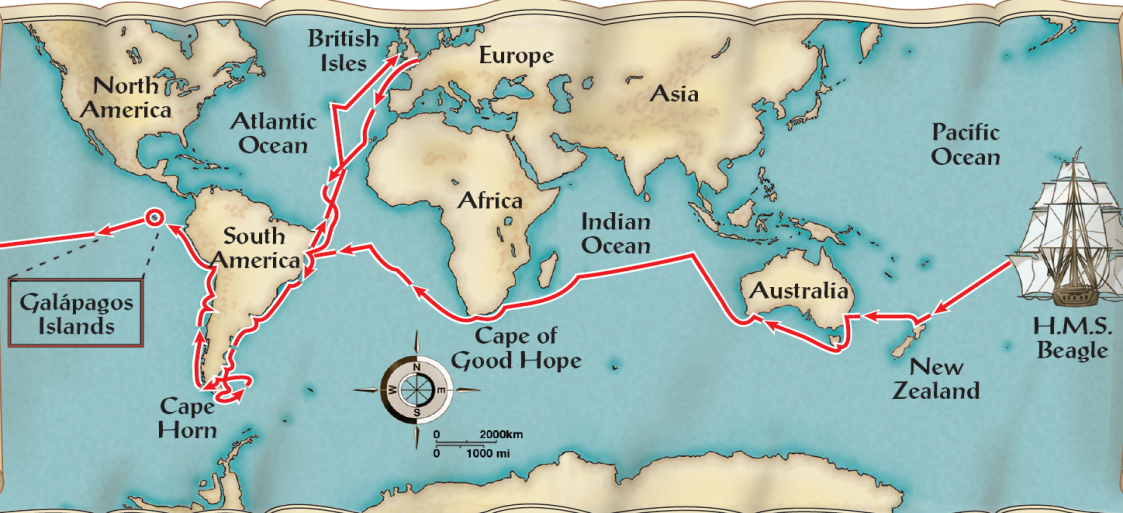
**Chapter 15 – Darwin’s Theory of Evolution**

Section 1 – The Puzzle of Life’s Diversity

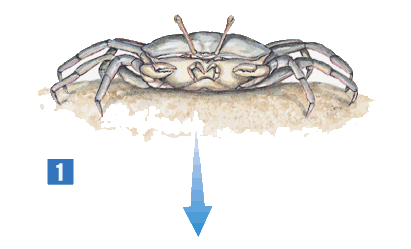
* **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** is the process by which modern organisms have descended from ancient organisms. (change)
* A scientific **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** is a well-supported testable explanation of phenomena that have occurred in the natural world.
* Voyage of the *Beagle*
  + In 1831, Darwin set sail from England aboard the H.M.S. *\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_* for a voyage around the world.
  + Darwin went ashore and collected plant and \_\_\_\_\_\_\_\_\_\_\_\_ specimens for his collection.
  + He studied the specimens, read the latest scientific books, and filled many notebooks with his \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and thoughts.

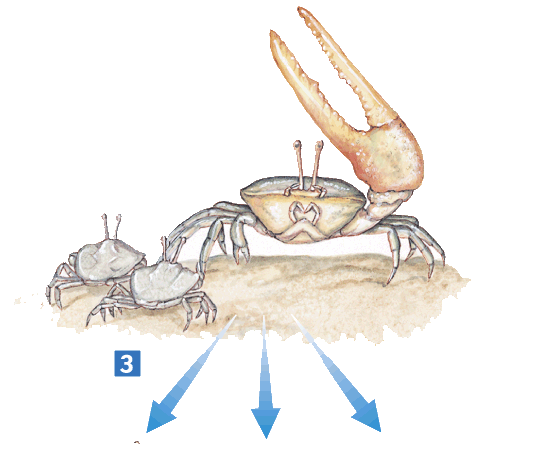
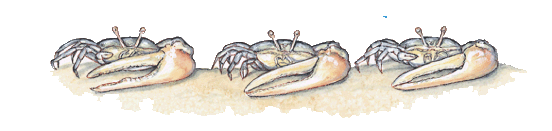


* What was Charles Darwin's contribution to science?
  + During his travels, Darwin made numerous observations and collected evidence that led him to propose a hypothesis about the way life \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ over time.
  + That hypothesis has become the theory of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Darwin's Observations
  + Darwin observed that many plants and animals were well suited to the environments they inhabited.
  + He was impressed by the ways in which organisms survived and produced \_\_\_\_\_\_\_\_\_\_\_.
  + Darwin was puzzled by where different species lived and did not live.
  + Grasslands in some regions were similar to one another but were inhabited by very \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ animals.
* Living Organisms and Fossils
  + Darwin collected the preserved remains of ancient organisms, called **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**.
  + Some of those fossils resembled organisms that were still alive.
  + Others looked completely \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ any creature he had ever seen.
* The Galápagos Islands
  + Darwin observed that the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Islands were close together but had very different climates.
* What pattern did Darwin observe among organisms of the Galápagos Islands?
  + Darwin observed that the characteristics of many animals and plants varied noticeably among the different \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the Galápagos.

Section 2 – Ideas that Shaped Darwin’s Thinking

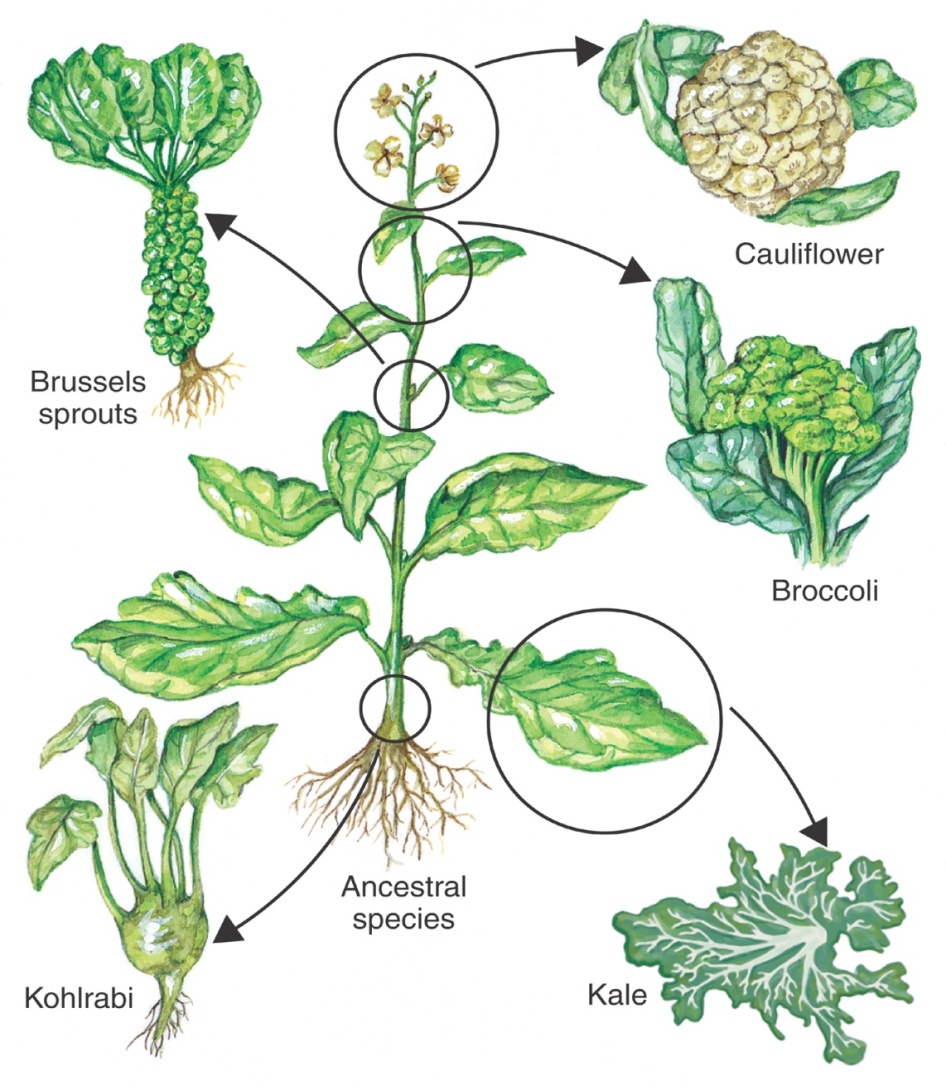
* An Ancient, Changing Earth
  + How did Hutton and Lyell describe geological change?
  + Hutton and Lyell helped scientists recognize that Earth is many \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of years old, and the processes that changed Earth in the past are the same processes that operate in the present.
* Hutton and Geological Change
  + In 1795, James Hutton published a hypothesis about the geological forces that shaped \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + Most of these geological forces operate very \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, over millions of years.
  + Hutton proposed that Earth had to be much more than a few thousand years old.
* Lyell's *Principles of Geology*
  + Lyell stressed that scientists must explain past events in terms of processes that they can actually \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + The processes that shaped the Earth millions of years earlier continue in the present.
  + Lyell’s work explained how geological features could be built up or torn down over \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ periods of time.
* **This understanding of geology influenced Darwin:** 
  + If the Earth could change over time, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ might change as well.
  + It would have taken many years for life to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the way Lyell suggested.
    - This would have been possible only if the Earth were extremely \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* According to Lamarck, how did species evolve?
* Lamarck's Evolution Hypotheses
* Jean-Baptiste Lamarck recognized that:
  + living things have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ over time.
  + all species were descended from other \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + organisms were \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to their environments.
* Lamarck proposed that by selective use or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of organs, organisms acquired or lost certain traits during their lifetime. These traits could then be passed on to their offspring. Over time, this process led to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in a species.
* Tendency Toward Perfection
  + Lamarck proposed that all organisms have an innate tendency toward complexity and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + They are continually changing and acquiring features that help them live more successfully in their environments.
* Use and Disuse
  + Lamarck proposed that organisms could alter the size or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of particular organs by using their bodies in new ways.
  + Example:
    - A male fiddler crab uses its front claw to ward off predators and to attract mates.
    - Because the front claw is used repeatedly, it becomes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
    - This characteristic (large claw) is passed onto its \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.





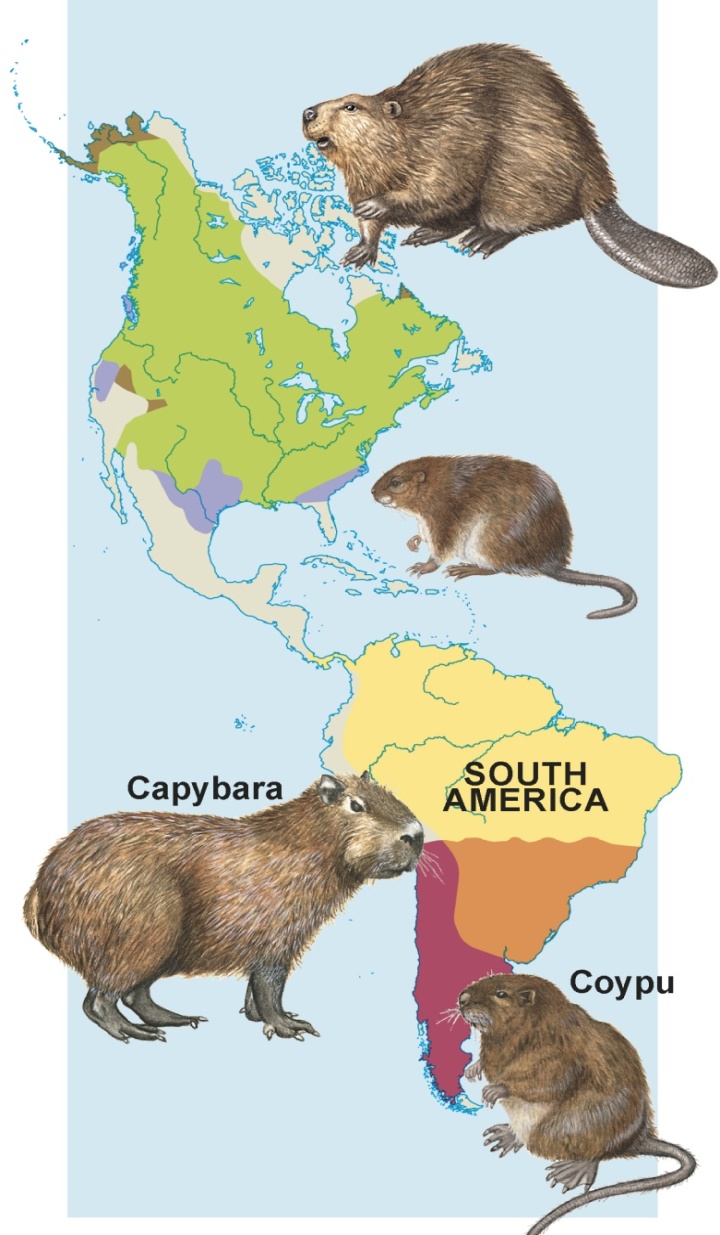
* Inheritance of Acquired Traits
  + Lamarck thought that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ characteristics could be inherited.
  + He believed that if an animal acquired a particular feature in its lifetime, that feature would be passed on to its \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Evaluating Lamarck's Hypotheses
* Lamarck’s hypotheses of evolution are incorrect in several ways.
* Lamarck did not know:
  + how traits are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + that an organism’s behavior has no \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on its heritable characteristics.
    - However, he paved the way for the work of later biologists.
* What was Malthus's theory of population growth?
* Population Growth
  + In 1798, Thomas \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ published a book in which he noted that babies were being born faster than people were dying.
  + The only forces he observed that worked against this growth were war, famine, and disease.
  + Malthus reasoned that if the human population continued to grow unchecked, sooner or later there would be insufficient living space and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for everyone.
  + When Darwin read Malthus’s work, he realized that this reasoning applied to plants and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + If all the offspring of almost any species survived for several generations, they would \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the world.
  + This information was central to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ explanation of evolutionary change.

Section 3 – Darwin Presents His Case (Part 1)

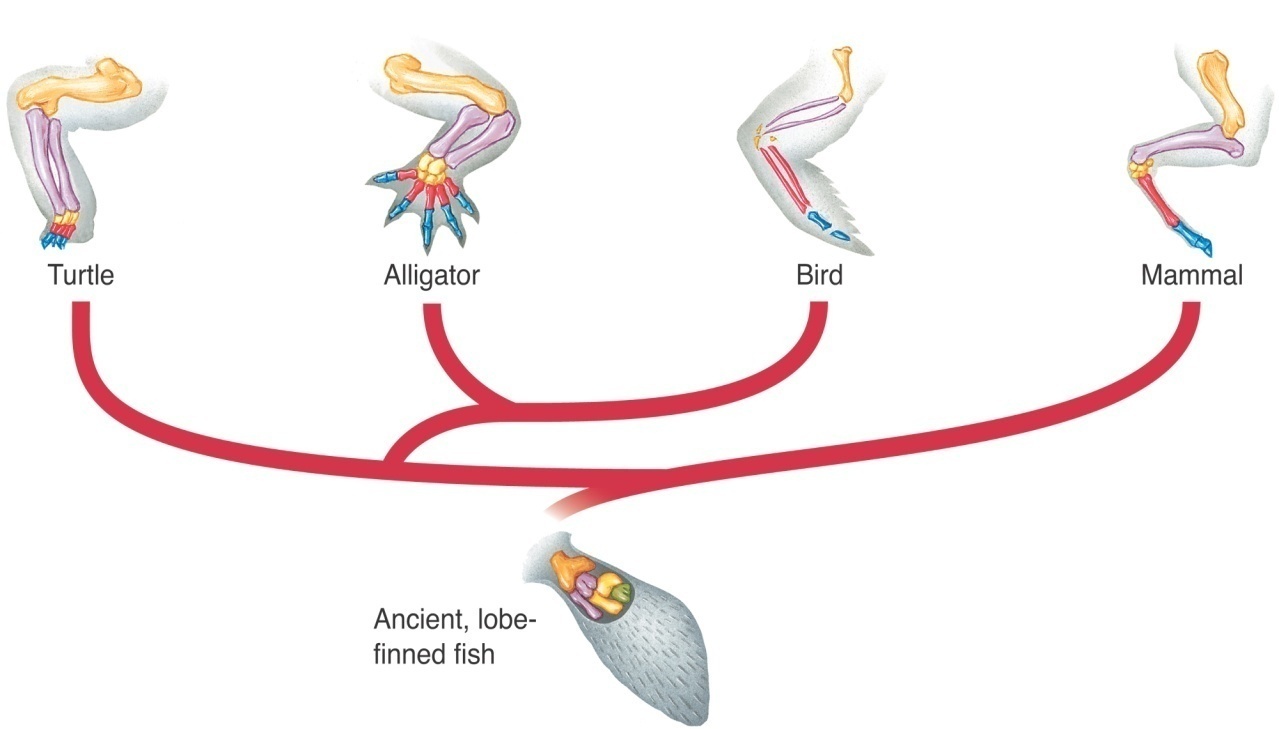
* Publication of *On the Origin of Species*
  + Darwin filled notebooks with his ideas about species diversity and the evolution process.
  + Darwin was \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and disturbed by his discoveries.
  + He shelved his manuscript for years and told his \_\_\_\_\_\_\_\_\_ to publish it in case he died.
  + In 1858, Darwin received a short essay from naturalist Alfred \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + The essay \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Darwin’s thoughts on evolutionary change.
  + Later that year, Wallace’s essay was presented with some of Darwin’s work.
  + In 1859, Darwin published his book, *On the Origin of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*.
* In his book, Darwin:
  + proposed a mechanism for evolution called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ selection.
  + presented evidence that evolution has been taking place for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of years—and continues in all living things.
* Inherited Variation and Artificial Selection
  + Members of each species vary from one another in important ways.
  + In Darwin’s day, variations were thought to be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, minor defects.
  + Darwin argued that this variation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + Darwin noted that plant and animal breeders would breed only the largest hogs, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ horses, or the cows that produced the most milk.
  + Darwin termed this process **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ selection**.
* How is natural variation used in artificial selection?
  + **Artificial selection** is the selection by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for breeding of useful traits from the natural variation among different organisms.
* Evolution by Natural Selection
  + Darwin compared processes in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to artificial selection.
  + By doing so, he developed a scientific hypothesis to explain how evolution occurs.
* The Struggle for Existence
  + Darwin realized that high birth rates and a shortage of life's basic needs would force organisms to compete for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + The **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for existence** means that members of each species compete regularly to obtain food, living space, and other necessities of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + The struggle for existence was central to Darwin's theory of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* How is natural selection related to a species' fitness?
  + Survival of the Fittest
  + The ability of an individual to survive and reproduce in its specific environment is **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**.
  + Darwin proposed that fitness is the result of adaptations.
  + An **adaptation** is any inherited characteristic that increases an organism's chance of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
    - Successful adaptations enable organisms to become better suited to their environment and better able to survive and reproduce.
  + Individuals with characteristics that are not well suited to their environment either \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or leave few offspring.
  + Individuals that are better suited to their environment survive and reproduce most successfully.
  + Darwin called this process **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**.
  + Because of its similarities to artificial selection, Darwin referred to the survival of the fittest as **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ selection**.
    - In natural selection, the traits being selected contribute to an organism's fitness in its environment.
  + Over time, natural selection results in changes in the inherited characteristics of a population. These changes increase a species' \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in its environment.

Section 3 – Darwin Presents His Case (Part 2)

* Descent With Modification
  + Natural selection produces organisms that have different structures, establish different niches, or occupy different \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + Each living species has descended, with changes, from other species over time.
  + Darwin referred to this principle as **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ with modification**.
  + Descent with modification implies that all living organisms are related to one another.
    - This is the principle known as **common \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**.
* What evidence of evolution did Darwin present?
* Evidence of Evolution
  + Darwin argued that living things have been evolving on Earth for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of years. Evidence for this process could be found in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ record, the geographical distribution of living species, homologous structures of living organisms, and similarities in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ development, or **embryology**.
  + The Fossil Record
    - Darwin saw fossils as a record of the history of life on Earth.
    - By comparing fossils from older rock layers with fossils from younger layers, scientists could document that life on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ has changed over time.
  + Geographic Distribution of Living Species
    - Darwin decided that all Galápagos finches could have descended with modification from a common mainland \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
    - Darwin’s theory was that species now living on different continents had each descended from different ancestors.
    - However, because some animals on each continent were living under similar ecological conditions, they were exposed to similar pressures of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ selection.
    - Because of these similar selection pressures, different animals ended up evolving certain features in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.



* Homologous Body Structures
  + Structures that have different mature forms but develop from the same embryonic tissues are called **homologous \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**.
  + Similarities and differences in homologous structures help biologists group animals according to how recently they last shared a common \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.



* Not all homologous structures serve important functions.
  + The organs of many animals are so reduced in size that they are just vestiges, or traces, of homologous organs in other species.
  + These organs are called **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ organs**.
* Similarities in Embryology
  + The early stages, or embryos, of many animals with backbones are very similar.
  + The same groups of embryonic cells develop in the same order and in similar \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to produce the tissues and organs of all vertebrates.
* Summary of Darwin's Theory
  + Individual organisms differ, and some of this \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is heritable.
  + Organisms produce more offspring than can survive, and many that do survive do not reproduce.
  + Because more organisms are produced than can survive, they compete for limited \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Individuals best suited to their environment survive and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ most successfully.
  + These organisms pass their heritable traits to their offspring. Other individuals die or leave fewer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + This process of natural selection causes species to change over time.
  + Species alive today are descended with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ from ancestral species that lived in the distant past.
  + This process, by which diverse species evolved from common ancestors, unites all organisms on Earth into a single tree of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Evolutionary Theory
  + Scientific advances in many fields of biology, geology, and physics have confirmed and expanded most of Darwin’s hypotheses.
  + Evolutionary theory continues to change as new data are gathered and new ways of thinking \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.