Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Darwin’s Theory of Evolution

**I. Introduction to Evolutionary Theory**

A. Biological Diversity

1. Many scientists have long pondered the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_on Earth.

 How did the millions and millions of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of so many shapes and sizes come to occupy so many \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on Earth?

2. The term “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” refers to the variety of living things that inhabit our planet.

3. Why do these organisms live where they do? How did these organisms arise? Which organisms are related to one another? What adaptations allow an organism to live in a particular place? How do organisms change over time?

4. These are the questions that are asked by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

B. What is a theory?

1. People often use the word “theory” to indicate that:

2. The term “theory” in a science class has a much different meaning.

3. Scientific Theory:

a)

b)

c)

4. Scientists continually \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the strengths and weaknesses of theories. As new evidence is uncovered, theories are:

5. Remember:

C. What is evolution?

1. Evolution means “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.”

2. Evolution is the process by which:

3. Evolutionary theory:

4. Modern scientists define evolution as a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ change in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ within a population from one generation to the next.

D. Who “discovered” evolution?

1. Many scientists have contributed ideas and evidence that support the theory of evolution. However, the individual who contributed more to our understanding of evolution than any other was \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. This unit will explain the work of several scientists, but the focus of the unit will be on the life of Charles Darwin, and how he developed his theory of evolution.

**II. Charles Darwin: A Brief Biography**

A. Charles Darwin was born in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on February 12, 1809, the same day as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. He was the 5th of six children. His parents were \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. He had a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ upbringing, and his family was a very \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ family.

B. Darwin’s grandfather, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, wrote a book in \_\_\_\_\_\_\_\_\_\_\_\_ called “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” in which he discussed how one species could “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” into another.

C. In 1825, Charles enrolled at Edinburgh University to study \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. He witnessed \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ taking place without \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and quickly realized that the study of medicine was not for him.

D. In 1827, Charles abandoned the study of medicine. He decided to study \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ at Cambridge. While training to be a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, he continued to pursue his love of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. He was an avid collector of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. He graduated in 1831.

E. Before Darwin could take a job as a cleric, he was offered a job as a “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” on a voyage around the world on the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Over the next five years Darwin visited four continents and collected: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

F. In 1835, the HMS *Beagle* made a 5-week stop in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

G. 1838: Once back home in England, Darwin began to formulate his ideas on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. He struggled with his decisions about publishing his theories because he knew they \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. He decided to gather more \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ before going public. Instead he published a book about his travels.

H. In 1858, more than \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ after returning home from his voyage, Darwin received a letter from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Wallace had arrived at the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ about \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as Darwin, and intended to publish his findings. Darwin realized that he must quickly publish the work he had spent years developing.

I. In 1859, Darwin published “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.”

J. 1869: Origin of Species was a bestseller worldwide and went into multiple editions. In the 5th edition, Darwin introduced the term “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.”

K. In 1871, Darwin published “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.”

L. Darwin died in \_\_\_\_\_\_\_\_\_\_\_\_ and was buried at \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**III. The Voyage of the HMS *Beagle***

A. In 1831, Charles Darwin completed his college studies and joined the crew of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. He set sail on a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ around the world.

B. This trip would become one of the most important voyages in the history of science. On this voyage, Darwin would \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that would lead him to propose his theory of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ about the way life \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

C. Whenever the *Beagle* would anchor, Darwin would go ashore and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. He also collected \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of organisms that no longer lived on Earth.

D. While at sea, Darwin spent much time \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. He studied his ever-growing collections of specimens, and filled notebook after notebook with his \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ about life on Earth.

**IV. Darwin’s Observations**

A. Darwin had always been interested in nature, and he knew quite a bit about the plants and animals that lived in England. On his travels, he quickly realized \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. During a single day in a Brazilian forest, Darwin collected \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

B. Patterns of Diversity:

1. Darwin made the observation that many of the plants and animals he observed were \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

For example, he noted that adaptations seen in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ organisms would not be seen in organisms living in a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. Adaptations:

3. These observations caused Darwin to speculate and ponder upon several questions:

a)

b)

c) Why do organisms live where they do? Why are the grasslands on one continent inhabited by different organisms than the grasslands of a different continent? Why are there no rabbits in Australia despite the fact that they could easily live in the habitats found there?

C. Fossils:

1. Fossil:

2. Darwin was an avid collector of fossils. Some of the fossils resembled organisms that were \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, while others were \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

3. Studying fossils led to even more questions:

a)

b)

4. Darwin noted the similarities and differences among many different organisms. He became convinced that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

D. The Galapagos Islands

1. The Galapagos Islands are:

This port of call proved to be the most influential on Darwin’s developing theory of how life on Earth changes.

2. The cluster of islands that compose the Galapagos Islands is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, but they have very \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The lower islands in the group are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The higher islands have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

3. It was very clear to Darwin that the organisms found on each island had \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that allowed them to survive \_\_\_\_\_\_\_\_\_\_\_\_\_ on that island. Adaptations that allowed for survival on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ would not be helpful at all on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

4. Darwin was particularly interested in the large \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the Galapagos. He could easily tell which island a turtle lived on by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The Hood Island tortoise has a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and a shell that is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_ around the legs and head. This allows the tortoise to:

The Isabela Island tortoise has a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ shell and a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Isabella Island has:

Tortoises from Pinta Island have a shell that is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ between the two forms.

5. It was clear to Darwin that the tortoises were adapted for their particular island, but how had these adaptations occurred?

E. The Journey Home

1. While heading home, Darwin spent most of his time studying his collections of organisms and making observations. Darwin began to wonder if animals living on different islands had once been \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. Darwin began to hypothesize that separate species evolved from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ after becoming \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ from one another.

**V. Ideas in Darwin’s Time**

A. Darwin lived in an exciting time of scientific discovery. New discoveries were being made, and many principles and ideas previously accepted were being challenged. Darwin was affected by other scientists and their work. In turn, Darwin changed the thinking of many scientists and nonscientists.

B. However, many people found Darwin’s ideas too shocking to accept. Reasons why many people found Darwin’s work unacceptable include:

1. Many people in Darwin’s day believed that:

 They believed that the Earth and all of its forms of life:

2. It was believed that since the creation of Earth and its life forms:

3. It was believed that rocks and major geological features had been produced:

C. The Earth is Ancient and Changing

1. During Darwin’s time, scientists were examining and studying the features on Earth in great detail. They began to study rock layers called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The data they collected suggested that the Earth was \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and had \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. Several scientists who formed important theories about the changes on Earth greatly affected and influenced Darwin.

3. These scientists began to collect evidence that showed the Earth is:

D. Georges Cuvier (1769 – 1832)

1. Cuvier was a pioneer in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, the study of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. He collected fossilized bones and spent years reconstructing the appearance of these animals. From these fossils he collected convincing evidence that:

2. Cuvier discovered that \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_ strata contain fossils that are increasingly \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ from living species.

He noted that the older the stratum:

He also discovered many “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ found in one stratum compared to the next stratum.

3. Cuvier’s hypothesis was termed “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.”

4. Catastrophism:

In other words, catastrophes in the past (such as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) were responsible for destroying certain species.

5. Cuvier’s work led to the acceptance of the ideas of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

E. James Hutton

1. In 1795, James Hutton published a detailed hypothesis about the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that have shaped the Earth.

2. Hutton’s hypothesis included the following ideas:

a)

b)

c)

d)

F. Charles Lyell (1797 – 1875)

1. Lyell’s idea was called “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.”

2. Principle of Uniformitarianism:

3. Charles Darwin was given a copy of Lyell’s book just before he set sail on the *Beagle*. By reading this book, Darwin understood much more about:

4. This new understanding of geology affected Darwin in two ways:

a) Darwin asked himself this question:

b) Darwin realized that in order for life to change over time, the Earth would have to be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

G. Jean-Baptiste Lamarck (1744 – 1829)

1. Lamarck was one of the first scientists to propose that:

2. In 1809, Lamarck published his hypothesis known as the “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.”

3. Theory of Acquired Characteristics:

4. In other words, if you spend your entire adult life weight lifting and building up muscle mass:

 If you lose a finger in an accident:

5. Although Lamarck’s theory was quickly rejected, it was important for several reasons:

a)

b)

c)

H. Thomas Malthus (1766 – 1834)

1. Thomas Malthus published a book in which he discussed his thoughts and ideas about \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. This book proved to have a great impact on Darwin’s developing theories.

2. In his book, Malthus noted that:

He reasoned that if the human population continued to grow at such a rapid rate:

3. After Darwin read the book published by Malthus, he realized that these ideas applied even more strongly to plants and animals.

4. Darwin knew that a plant might produce \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, but that every single seed did not result in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Only a \_\_\_\_\_\_\_\_\_\_\_\_ portion of the seeds would \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and grow into a new plant. Further, of the seeds that did germinate and grow, only a small number of those would be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in their own \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

5. What factor or factors determine which offspring will \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and which will not? This key question is the foundation of Darwin’s theory of evolution.

**VI. Darwin Develops His Theory of Evolution**

A. What happened when Darwin returned home from his voyage on the *Beagle*?

1. Darwin arrived back in England in \_\_\_\_\_\_\_\_\_\_\_. He would not publish his theories on evolution until \_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. Once back in England, Darwin began to earnestly study the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that he had collected on his trip. He filled notebook after notebook with his ideas about the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on Earth and how it had changed (\_\_\_\_\_\_\_\_\_\_\_\_\_\_) over time.

3. During his trip around the world, Darwin noticed many examples of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Adaptations are:

4. Darwin explained that organisms become “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

According to Darwin, natural selection is a process in which:

5. Darwin was \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ his ideas. Apparently he was concerned about the uproar his ideas would cause. His ideas challenged:

6. Darwin continued his studies, but he shelved his manuscripts for many years. He instructed his wife to publish them in the event of his death.

B. What changed?

1. In 1858, Darwin received a letter from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. In his letter, Wallace summarized his thoughts on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Wallace had arrived at the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that Darwin had been developing for the previous 25 years.

2. Wallace intended to publish his findings. Darwin realized that he must quickly publish the work he had spent years developing.

3. Eighteen months later, in 1859, Darwin published his book:

4. In his book, Darwin proposed a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that he called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. He presented evidence that evolution has been occurring for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and continues in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

5. As expected, his book caused an uproar. Some felt Darwin’s arguments were \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, while others were \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**VII. Darwin’s Theory of Evolution: Descent With Modification**

A. In his book, Darwin discusses “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.” By using this term, Darwin hypothesized that:

B. Darwin carefully presented his evidence for his hypothesis. For example, while in the Galapagos Islands, Darwin observed \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Each species has a \_\_\_\_\_\_\_\_\_\_\_\_\_ that is adapted to acquiring a very specific \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Darwin thought that all 13 species descended from and diverged from a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

C. Darwin thought that over millions of years, the descendants of these ancestors had accumulated “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” or adaptations that “\_\_\_\_\_\_\_\_” them to a specific environment. This “descent with modification” led to the diversity of life on Earth today.

D. Artificial Selection

1. Darwin noted that plant and animal breeders were aware of the variations that existed in living organisms, and through selective breeding, they could \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. Selective breeding:

3. Darwin noted that farmers would routinely select for breeding only the:

4. Darwin called this process \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

5. Artificial Selection:

**VIII. Evolution by Natural Selection**

A. Darwin's Evolutionary Theory is based on the following concepts:

1. Organisms beget \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. There is stability in the process of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. In any given population, there are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ among individual organisms. Some of these variations are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

3. The “struggle for existence”:

For example, the predators that are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, have longer \_\_\_\_\_\_\_\_\_\_\_ or sharper \_\_\_\_\_\_\_\_\_\_ will catch more \_\_\_\_\_\_\_\_\_\_\_. Prey that are \_\_\_\_\_\_\_\_\_\_\_ or better \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ live longer to reach \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ maturity. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and certain favorable \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ determine which organisms live to reproductive age.

4. The number of individuals that survive and reproduce in each generation is:

5. Which individuals will \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and which will not is determined by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ an organism is to its \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Darwin called the ability of an individual to survive and reproduce in its specific environment “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.”

6. Fitness is the result of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. An adaptation is:

7. Individuals with characteristics that are not well suited to their environment either:

8. Individuals with characteristics well suited to their environment \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ more successfully, passing these \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. This became known as “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.”

B. This is the process that Darwin called “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.”

1.

2. Natural Selection:

3. Over time, natural selection results in changes in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ characteristics of a population. These changes increase the “fitness” of a species to its environment.

C. Common Descent

1. Darwin’s idea of “descent with modification” implies that all living organisms are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. This is the principle of “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_”:

D. The Controversy

1. Darwin’s ***“The Origin of Species”*** was truly radical for its time. It caused such a controversy because it went against two widely accepted premises:

a)

b)

2. Darwin envisioned life as evolving by a gradual \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and he postulated that natural selection operating over vast amounts of time could account for the entire \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

E. To summarize, the main features of the Darwinian view of life:

1. Individual organisms have different \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. These variations are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. Organisms produce \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ than can \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Of those that do survive, many will never \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

3. Because more organisms are produced than can survive, there is:

4. Individuals \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to the environment are more likely to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and reach \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. These organisms pass their heritable traits on to their offspring.

5. Organisms less suited for a particular environment often \_\_\_\_\_\_\_\_\_\_. If they do survive, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

6. This process of natural selection causes species to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

7. The species that are alive today are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that lived in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

F. Important points about natural selection:

1.

2.

3. Environmental factors vary from place to place over time. A trait that is favored in one place may be useless, or harmful, in another place.

**IX. The Evidence for Evolution**

A. Darwin argued that life on Earth had been changing and evolving for millions of years. The following areas provide evidence for evolution.

1.

2.

3.

4.

5.

B. The Fossil Record

1. Fossil:

2. Fossils provide the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of evolution.

3. Fossils are a record of the history of life on Earth. Many fossils have been found of organisms that are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. These extinct fossils resemble organisms that are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The fossil evidence shows that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ from present-day organisms and that many species have become \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The fossil record shows when new groups appeared in Earth’s history and how they changed over time.

4. By comparing fossils from \_\_\_\_\_\_\_\_\_\_\_\_ rock layers with fossils from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ rock layers, scientists can document that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

5. Scientists seek to determine both the “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” and the “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” of a fossil.

6. The relative age is:

For example, when scientists study rock layers, or strata, fossils found at \_\_\_\_\_\_\_\_\_\_\_\_\_\_ strata are deemed \_\_\_\_\_\_\_\_\_\_\_\_\_\_ than those fossils found at \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ strata.

7. Absolute age is the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. It is determined through \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Fossils contain \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that have a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The age of a material can be determined by:

8. What is learned from fossils?

a)

b)

c) Fossils found in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ layers are more like each other than to fossils found in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ layers.

d) By comparing fossils from around the world, scientists can determine \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

e) Fossils provide evidence about the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in which the organism existed and in how the organism was \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to that environment.

9. By observing \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, scientists can determine how organisms have changed over time. Transitional fossils have:

10. In 1862, the first skeleton of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ was found. This creature had characteristics of both \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. It is believed that birds evolved from the reptiles. This fossil was the "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" between the reptiles and the birds.

C. Biogeography: The Geographic Distribution of Organisms

1. Biogeography is the study of:

It refers to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the various regions of the world.

2. Darwin wondered why places \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ were populated by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Yet, when he looked at similar environments on those continents, he sometimes saw that:

3. Darwin concluded that species now living on different continents had each descended from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. However, because some animals on each continent were living under \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, they were exposed to similar \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

4. Because of these similar selection pressures, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ended up evolving with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

5. How can two species that look very different from each other be more closely related than two other species that look similar to each other?

D. Homologous Body Structures

1. Species that have common ancestors should have similar characteristics. Similarity in characteristics resulting from common ancestry is known as “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_”.

2. Homologous structures:

a) Homologous structures are:

b) Example: Compare the bone structure seen in the wing of a bat, the flipper of a whale, the foreleg of a cat, and the arm of a human.

c) These animals show:

d) Over time, each of these limbs has \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in ways that enable organisms to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

e) What conclusion can be reached about the homologous bone structure seen in these 4 animals?

3. Vestigial Organs

a) Vestigial organs are structures that:

b) Vestigial structures are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of structures that had important functions in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

c) Example: The skeletons of present day whales reveal remnants of hipbones and leg bones.

d) Example: The human tailbone, or coccyx, is made up of four fused vertebrae that resemble the bones in an animal’s tail.

e) Vestigial structures in living organisms:

E. Embryology

1. Embryology is:

2. Many embryos of organisms of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ look very \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in their early stages of development.

3. For example: All vertebrate (fish, amphibian, reptile, bird and mammal) embryos have structures called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in their throat regions and a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ at some point during their development. Although these embryos are very alike at early stages of development, these similarities fade as development proceeds.

4. One explanation for these similarities in embryological development is that:

F. Biological Molecules

1. Scientists also observe similarities among organisms at the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. All species of life have the same basic genetic machinery of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

3. All types of green plants have similar \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**X. Evolution in Action**

A. Darwin believed evolution to be such a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that it could never be observed directly. However, the effects of human civilization have produced such extremely strong ***\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*** on some organisms that it has been possible to observe not only the results but also the actual process of evolution by natural selection.

B. Example of evolution in progress: The Peppered Moth

1. The peppered moth is commonly found in Britain.

2. These moths were usually found on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Against this background, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the moth made them practically \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, concealing them from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

3. In 1845 one \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of this species was captured living in an industrial section.

4. With increasing industrialization of the period, the pollution \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The trees and rocks became \_\_\_\_\_\_\_\_\_\_\_\_ from heavy pollution from the burning of \_\_\_\_\_\_\_\_\_\_\_\_\_\_.

5. More and more \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ were found, until they made up \_\_\_\_\_\_\_\_\_\_\_ of the moth population.

6. The black color was the result of a rare mutation. The black moths had always been \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, but in very small \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. They were usually \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because their black color stood out against the light lichens. Since they were not living to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, they were not passing down the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

7. As the smog turned the trees black, the black moths had a better \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and began to live to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Thus the black allele was passed down with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because now the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ were being eaten.

8. In the 1950's strong pollution controls were implemented. Less pollution brought a return of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The number of white colored moths \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as a result.

9. Neither the black moths nor the white moths are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. It is simply a matter of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ by the environment at a given time.

C. Example of evolution in progress: The Evolution of Insecticide Resistant Insects

 Whenever a new insecticide is used, the results are usually the same. The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the new insecticide may kill \_\_\_\_\_\_\_\_ of the insects it is intended to kill. Subsequent sprayings will be less and less \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The relatively few survivors of the first spraying are insects with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that somehow enable them \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The poison kills most members of the target population, but leaves the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ members to reproduce. The survivors pass these \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on to their offspring. In each generation, the proportion of insecticide resistant individuals \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The population has adapted to a change in the environment.

**XI. Patterns of Evolution**

A. There are several ways that species can change to adapt to their environments. The pattern and speed of evolution depends on the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. This is called ***\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***.

B. The large-scale evolutionary patterns and processes that have occurred over large periods of time are the result of the following processes:

1.

2.

3.

4.

5.

6.

C. Extinctions

1. More than \_\_\_\_\_\_\_\_\_\_\_\_ of all species that have ever lived are now extinct.

2. Reasons for extinctions include:

a) Species have to compete for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and often one species is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the resource than a competitor. The competitor is driven to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

b) The environment changes and some species \_\_\_\_\_\_\_\_\_\_\_\_ while others \_\_\_\_\_\_\_\_\_\_\_\_\_\_.

c) Gradual extinctions occur due to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

d) Occasionally extinctions are not caused by ordinary natural selection, but by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in Earth’s history. Mass extinctions wipe out entire \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. During a mass extinction, species become extinct due to the environmental collapse that is occurring around them, rather than the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

e) Example: At the end of the Cretaceous Period, it is hypothesized that a huge \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ impacted with the Earth. A huge amount of dust and water vapor was thrown into the atmosphere, causing dramatic \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The large-scale mass extinction that followed was not caused by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, but by a complete \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in environment.

3. There have been many mass extinctions in Earth’s history.

4. ***This is important!*** What effects have mass extinctions had on life on Earth?

D. Adaptive Radiation

1. Adaptive radiation is:

2. Adaptive radiations have occurred many times in Earth’s history. Examples include:

a) The evolution of the first \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as they were the first vertebrates to colonize the landmasses.

b) The arrival of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

c) The explosion of new \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that occurred when the dinosaurs became extinct.

E. Convergent Evolution

1. Convergent evolution:

2. Closely related organisms share characteristics because of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Distantly related organisms can come to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ one another because of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. These organisms face similar environmental \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and will often develop similar \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to meet the demands of the environment.

3. In convergent evolution:

An example is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. These two organisms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ one another even though they are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ related.

They were:

4. Since the shark and dolphin adapted to similar environments in similar ways, they developed \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. There is very little \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ between the \_\_\_\_\_\_\_ of the shark and the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the dolphin. The dolphin has a skeleton made of \_\_\_\_\_\_\_\_\_\_\_\_\_, and the shark has no bones, only \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. These structures are analogous since they have:

They evolved in this way in response to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that was placed on them.

5. Even penguins, which are birds, show a similar \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as sharks and dolphins. Here we have an example of fish, mammals, and birds developing similar \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to meet the demands of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in which they live.

F. Divergent Evolution

1. In divergent evolution:

2. The descendants of a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ diversify into species that each fit different parts of the environment.

3. Example:

a) Assume that a small number of lizards are introduced on an island.

b) The lizards show variations in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

c) Lizards with:

d) Lizards with:

e) Eventually, each group may become a separate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

G. Coevolution

1. Coevolution:

2. In coevolution, an evolutionary change in one organism may also be followed by:

3. Example: Insects have been feeding on plants since insects evolved. In response, many plants developed \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to prevent insects from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on them. Natural selection favored any insect that could \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Those insects then \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and produced a population of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ who could also withstand the effect of the toxin or poison. This is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ since one species evolved in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

H. Punctuated Equilibrium

1. Darwin was convinced that evolution was a very slow process that occurred over a very long time. In many cases, the fossil record confirms that some species did evolve very slowly over time. This idea was known as ***\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***.

2. Most of the time, species are in a state of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, meaning they are not changing very much. However, every now and then, something happens to upset this equilibrium. When this equilibrium is upset, changes in organisms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

3. The equilibrium can be upset when:

a)

b)

c)

4. Punctuated equilibrium is a term used to describe a pattern of: