**The Theory of Evolution**

Why Its Important: Evolution is the key concept to understanding biology. It explains the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of species and predicts \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
| Objectives | Vocabulary |
| * **Identify** several observations that led Darwin to conclude that species evolve. * **Relate** the process of natural selection to its outcome. * **Summarize** the main points of Darwin’s theory of evolution by natural selection as it is stated today. * **Contrast** the gradualism and punctuated equilibrium models of evolution. | * Population * Natural Selection * Adaptation * Reproductive Isolation * Gradualism * Punctuated equilibrium |

**Darwin Proposed a Mechanism for Evolution**

* In 1859, the English naturalist Charles \_\_\_\_\_\_\_\_\_\_\_ published convincing \_\_\_\_\_\_\_\_\_\_\_\_\_\_ that species evolve, and he proposed a reasonable mechanism explaining \_\_\_\_\_\_\_\_ evolution occurs. Like all scientific theories, the theory of evolution has developed through decades of scientific \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Darwin made many of his observations while traveling around the world on a ship called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

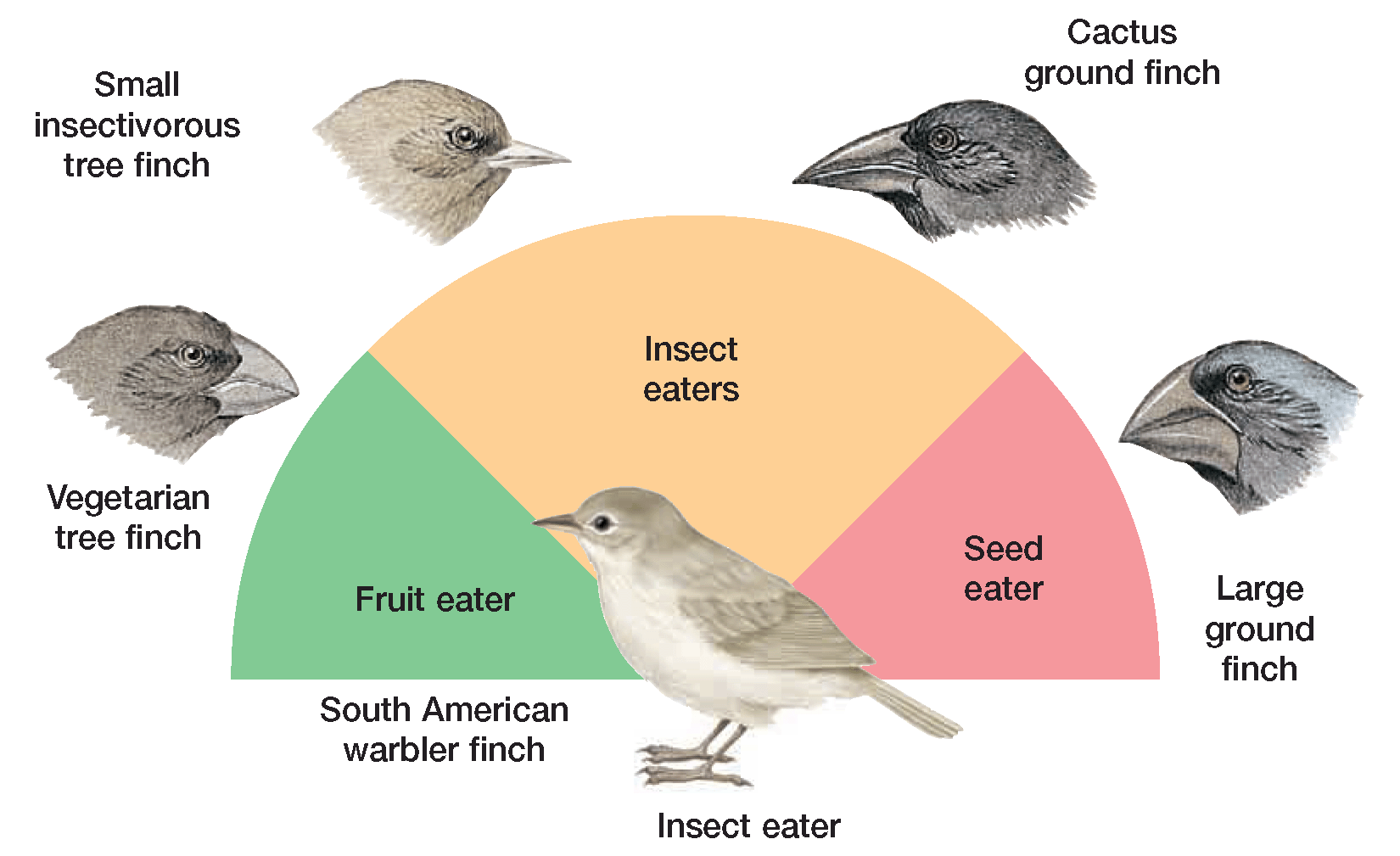
**Science Before Darwins Voyage**

* In 1859, the English naturalist Charles \_\_\_\_\_\_\_\_\_\_\_ published convincing \_\_\_\_\_\_\_\_\_\_\_\_\_\_ that species evolve, and he proposed a reasonable mechanism explaining \_\_\_\_\_\_\_\_ evolution occurs. Like all scientific theories, the theory of evolution has developed through decades of scientific \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Darwin made many of his observations while traveling around the world on a ship called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* We now know that individuals cannot gain new adaptations during their lifetime, rather they are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Ex: giraffes do not acquire long necks by reaching for leaves on trees
* However, Lamarck did correctly point out that changes in species are due to their \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ conditions. Ex: If around tall trees, giraffes with longer necks will survive better than ones with short necks

**Darwins Observations**

* On the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ islands, Darwin found evidence that challenged the traditional belief that species are unchanging. This group of islands is located about 1000km (620 mi) off the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ coast of South America. On the islands, Darwin noticed that many of the plants and animals \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ those of the nearby coast of South America.
* Darwin proposed that after these organisms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to the islands, they changed \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ overtime
* He later called this change “descent with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” or evolution

**Example: The evolution of different bird beaks based on the \_\_\_\_\_\_\_\_ available in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

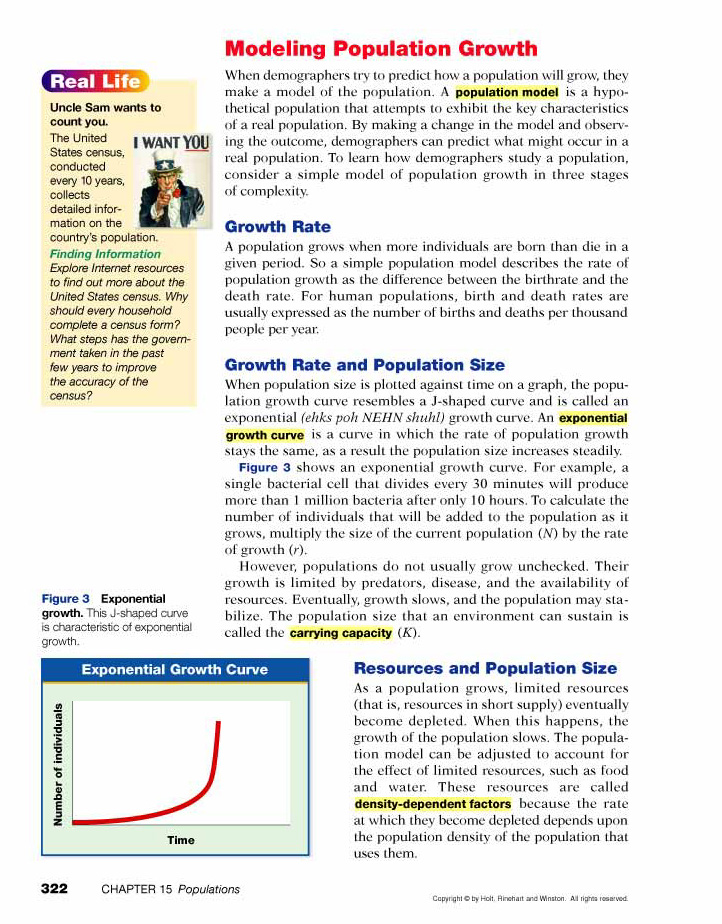


**Why might the large ground finch be a good seed eater?**

* Darwin also found \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of extinct armadillos in South America
  + These fossils \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ resembled, but were not identical, to armadillos living in the area
  + When Darwin returned home, he continued to study his findings for two \_\_\_\_\_\_\_\_\_\_\_\_\_. He was certain that evolution occurred, he just didn’t know \_\_\_\_\_\_\_.

**Growth of Populations**

* The key that unlocked Darwin’s thinking about how evolution takes place was an essay written in 1798 by the English economist Thomas \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + Malthus suggested that human populations do not grow \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because death caused by disease, war, and famine \_\_\_\_\_\_\_\_\_\_\_\_\_ population growth.
* In the study of biology, a **population** consists of all the individuals of \_\_\_\_\_\_\_ species that live in a specific geographical \_\_\_\_\_\_\_\_\_\_ and that can \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* If populations grow \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, they show an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ pattern of growth
* This growth pattern is also



called \_\_\_\_\_ shaped

growth and continually

increases as the population

grows

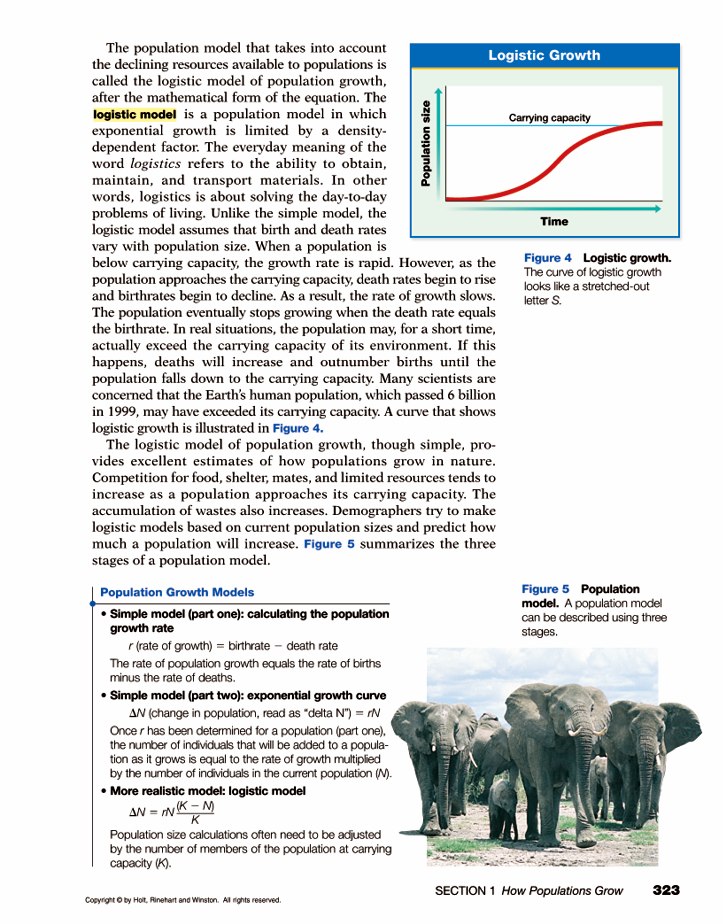
* Common in organisms

that reproduce \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* The growth of most larger organisms is slowed or “checked” by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ factors, like \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Growth usually stabilizes

at a population’s

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* This growth is called   
  \_\_\_\_ shaped growth and

is common in organisms

with \_\_\_\_\_\_\_\_\_\_\_\_\_\_ life spans

* When Thomas Malthus wrote his

paper, he thought that human

population growth would soon begin to \_\_\_\_\_\_\_\_\_ down, due to limiting factors. He probably would have been correct, if the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ revolution soon did not occur

* + Better technology made it easier for humans to survive and we have been showing \_\_\_\_\_ shaped growth ever since
* After reading Malthus’s essay, Darwin recognized that many species produce \_\_\_\_\_\_\_\_\_ offspring, but their population growth is still slowed by limiting factors like \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + and…individuals that have physical or behavior \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that are better adapted to their environment are more likely to \_\_\_\_\_\_\_\_\_\_\_ and will \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ more successfully than those that do not have such traits

**Evolution By Natural Selection**

* Remember, adaptations and traits are controlled by \_\_\_\_\_\_\_\_\_\_\_\_, which are inherited
* An adaptation is a feature that has become common in a population because the feature provides a selective \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in a specific \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Darwin called this differential rate of reproduction **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.**
* In \_\_\_\_\_\_\_\_, Darwin finally wrote down his ideas about evolution and natural selection in an early outline that he showed to only a \_\_\_\_\_\_ scientists he knew and trusted.
* Darwin decided to publish after he received a letter and essay in \_\_\_\_\_\_\_\_ from another naturalist named Alfred Russel \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ , who also supported the idea of evolution by natural selection.
* Darwin’s published work was a book called…

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ *by Means of Natural Selection*

Many people were deeply \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ by Darwin’s theory…but it is supported by four major points…

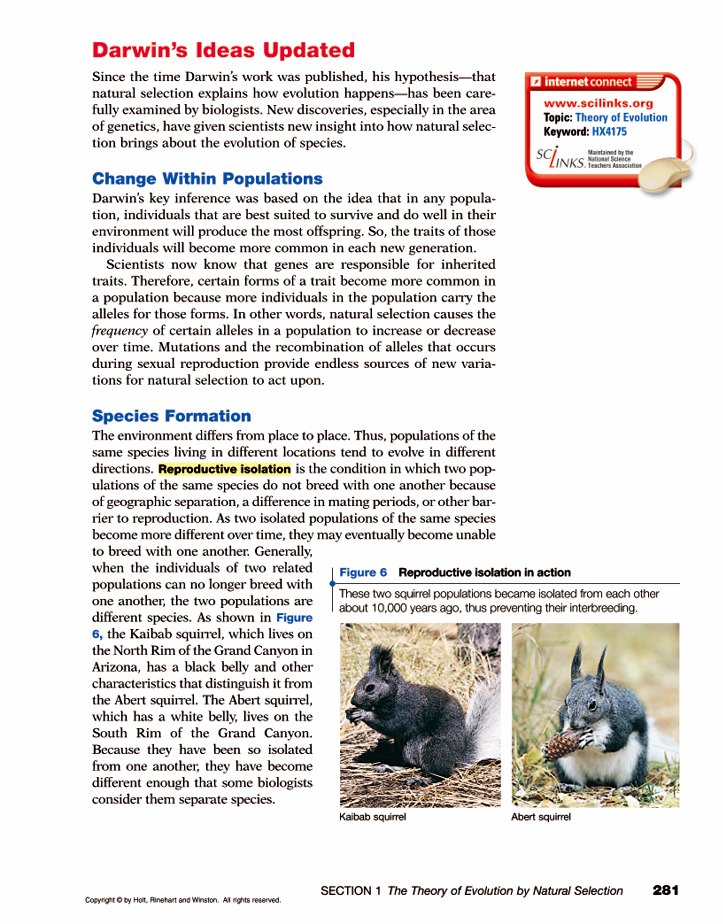
* 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ exists within the genes of every population or species.
  2. In a particular environment, \_\_\_\_\_\_\_\_\_\_ individuals of a population or species are better suited to survive and have more offspring
  3. Overtime, the traits that make certain individuals of a population able to survive and reproduce tend to \_\_\_\_\_\_\_\_\_\_\_\_\_\_ in that population
  4. There is overwhelming evidence from \_\_\_\_\_\_\_\_\_\_\_\_ that living species evolved from organisms that are \_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Darwins Ideas Updated**

* Darwin’s ideas are further supported by the discovery that an organism’s traits are determined by the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that they \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* So, evolution occurs in a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of certain alleles increases or decreases over time.
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of alleles that occurs during sexual reproduction provide an endless source of new \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for natural selection to act upon
  + Keep in mind that most mutations are \_\_\_\_\_\_\_\_\_\_\_\_\_\_, but if the mutation is beneficial, it will end up \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in a population

**How are New Species Formed?**

* Populations of the same species living in different locations tend to evolve in different \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* When members of a population became separated physically or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, they are also \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **isolated** because they can no longer \_\_\_\_\_\_\_\_
* What are some examples of geographical structures that can separate a population?
* As members of a divided population reproduce separately, DNA \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or changes in mating \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ may prevent them from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ even if they are in the same location
* When members of a population can no longer interbreed, they are considered \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ species
* Example… A squirrel population became isolated in different areas of the Grand Canyon



In one population, squirrels with

\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_bellies were more successful, and in another population squirrels with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ bellies were more successful

* A similar pattern of evolution was observed in peppered moths
  + Lighter variations became more prevalent in England’s country side, while darker variations became more prevalent in England’s cities…

[](http://en.wikipedia.org/wiki/File:Biston.betularia.7200.jpg)

[](http://en.wikipedia.org/wiki/File:Biston.betularia.f.carbonaria.7209.jpg)

* + Hypothesis?
* The genetic darkening of a population due to pollution has been coined

industrial \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* + Melanin – pigment

**The Tempo of Evolution**

* For decades, most biologists have understood evolution as a \_\_\_\_\_\_\_\_\_\_\_\_\_ process that occurs continuously .
  + This model of evolution is called \_\_\_\_\_\_\_\_\_\_\_\_**.**
* Another model of evolution, in which periods of \_\_\_\_\_\_\_\_\_\_\_ change in species are separated by periods of little or \_\_\_\_\_change, is called **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
  + **Usually seen after major \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ changes and mass \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

1. **Identify** several observations that led Darwin to conclude that species evolve.
   1. Organisms on the Galapagos Islands?
   2. Armadillo fossils in South America?
2. **Relate** the process of natural selection to its outcome.
3. **Summarize** the main points of Darwin’s theory of evolution by natural selection as it is stated today.
   1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ exists within the genes of every population or species.
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   3. Overtime, the traits that make certain individuals of a population able to survive and reproduce tend to \_\_\_\_\_\_\_\_\_\_\_\_\_\_ in that population
   4. There is overwhelming evidence from \_\_\_\_\_\_\_\_\_\_\_\_ that living species evolved from organisms that are \_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. **Contrast** the gradualism and punctuated equilibrium models of evolution.

**Evidence of Evolution**

|  |  |
| --- | --- |
| Objectives | Vocabulary |
| * **Describe** how the fossil record supports evolution. * **Summarize** how biological molecules such as proteins and DNA are used as evidence of evolution. * **Infer** how comparing the anatomy and development of living species provides evidence of evolution. | * Paleontologist * Vestigial Structure * Homologous structure |

* Evidence that supports the theory of evolution comes from different sources…
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Fossils provide an actual \_\_\_\_\_\_\_\_\_\_\_\_\_ of Earth’s past life-forms and evidence that indicates \_\_\_\_\_\_\_\_\_\_\_\_\_ over time

* After noticing changes in fossils, Darwin predicted that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ forms between the great groups of organisms would be discovered…
  + While the fossil record is incomplete, some intermediate fossils have been found between…
    - Fishes and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - Reptiles and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - Reptiles and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* The fossil record has led most scientists to agree that….

1. Earth is about 4.5 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ years old.

2. Organisms have inhabited Earth for \_\_\_\_\_\_\_ of its history.

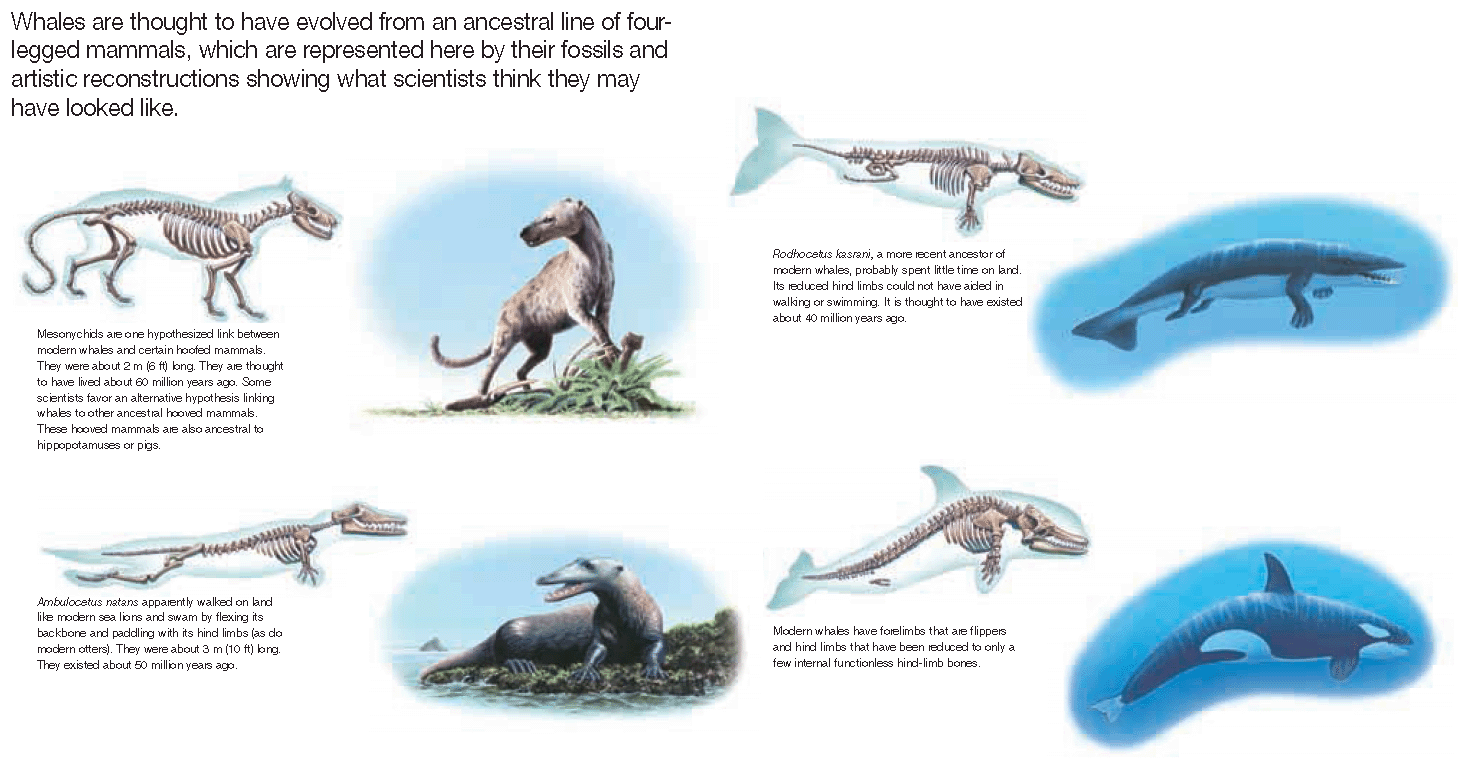
3. All organisms living today share \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ancestry with earlier, simpler life-forms, based on the principle of \_\_\_\_\_\_\_\_\_\_\_\_

**Formation of Fossils**

* **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are** scientists who study fossils.
* \_\_\_\_\_\_\_\_\_ radiometric dating and relative dating are used to arrange fossils in \_\_\_\_\_\_\_\_\_\_\_\_\_\_ from oldest to youngest

**Evidence of Whale Evolution**

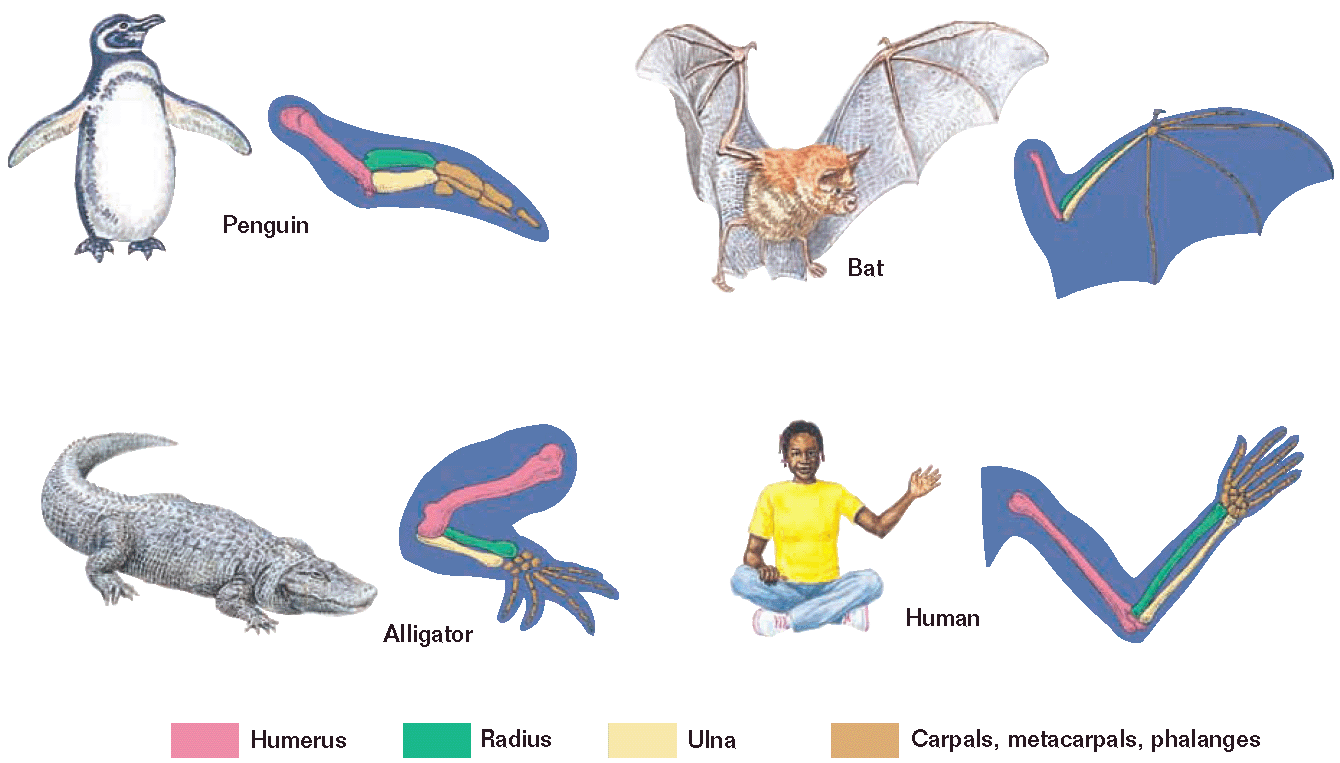
* For example, whales are thought to have evolved from extinct, four-legged mammals called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



* Fossils indicate that traits helpful for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ may have been passed along
* Modern whales have forelimbs that are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and hind limbs that have been reduce to only a \_\_\_\_\_\_\_\_ bones
* The fossil record is incomplete because not all organisms are preserved…
  + For fossils to form, dead organisms must quickly be covered in layers of sediment before they \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Fossils also only form in layers of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ rock, which forms at relatively \_\_\_\_\_\_\_\_ temperatures and pressures
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ rock, which forms at \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ temperatures and pressure, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ fossils

**Anatomy & Development**

* Comparisons of the anatomy of different types of organisms often reveal basic \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in body structures even though the structure’s \_\_\_\_\_\_\_\_\_\_\_\_\_ may differ slightly between organisms.
* **Similar structures, called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ structures, indicate a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ancestry**
* What is similar about these homologous structures?



* Sometimes structures are present in an organism, but are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in size and either have \_\_\_\_\_\_ use or a \_\_\_\_\_\_\_\_\_\_\_ important function than they did in a previous ancestor…

Examples…

* + Whale hind limb bones
  + Ostrich wings
  + Human appendix
  + Vestigial snake feet (buds)

**Embryonic Development**

|  |  |
| --- | --- |
| Untitled-30 copy | The evolutionary history of organisms is also seen in the development of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.  At some time in their development, all vertebrate embryos  have a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that become limbs, and pharyngeal pouches  The tail remains in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ adult vertebrates. Only adult fish and immature amphibians retain pharyngeal pouches which contain their \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. |

**Biological Molecules**

**DNA and Proteins**

* As species evolve, changes should have become a part of their \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ instructions. Therefore, more and more changes in a gene’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ sequence should build up over time.
* Since DNA codes for the production of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

species that have descended from a recent common ancestor should have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ amino acid differences between their proteins than more distant species.

|  |  |
| --- | --- |
| **Hemoglobin Comparison** | |
| Untitled-6 copy | Which organism differs most from humans according to the type of amino acids present in its hemoglobin protein?  And the least different from humans? |

1. **Describe** how the fossil record supports evolution.
2. **Summarize** how biological molecules such as proteins and DNA are used as evidence of evolution.
3. **Infer** how comparing the anatomy and development of living species provides evidence of evolution.

Anatomy

Development

**Evolution of Populations**

|  |  |
| --- | --- |
| Objectives | Vocabulary |
| * Identify four elements in the process of natural selection * Describe how natural selection has affected the bacteria that cause tuberculosis * Relate natural selection to the beak size of finches * Summarize the process of species formation * Identify the Hardy-Weinberg principle * Describe the five forces that cause genetic change in a population * Identify why selection against unfavorable recessive traits is slow * Contrast directional and stabilizing selection | * Divergence * Speciation * Subspecies * Hardy-Weinberg principle * Gene flow * Nonrandom mating * Genetic drift * Normal distribution * Directional selection * Stabilizing selection |

**Natural Selection at Work**

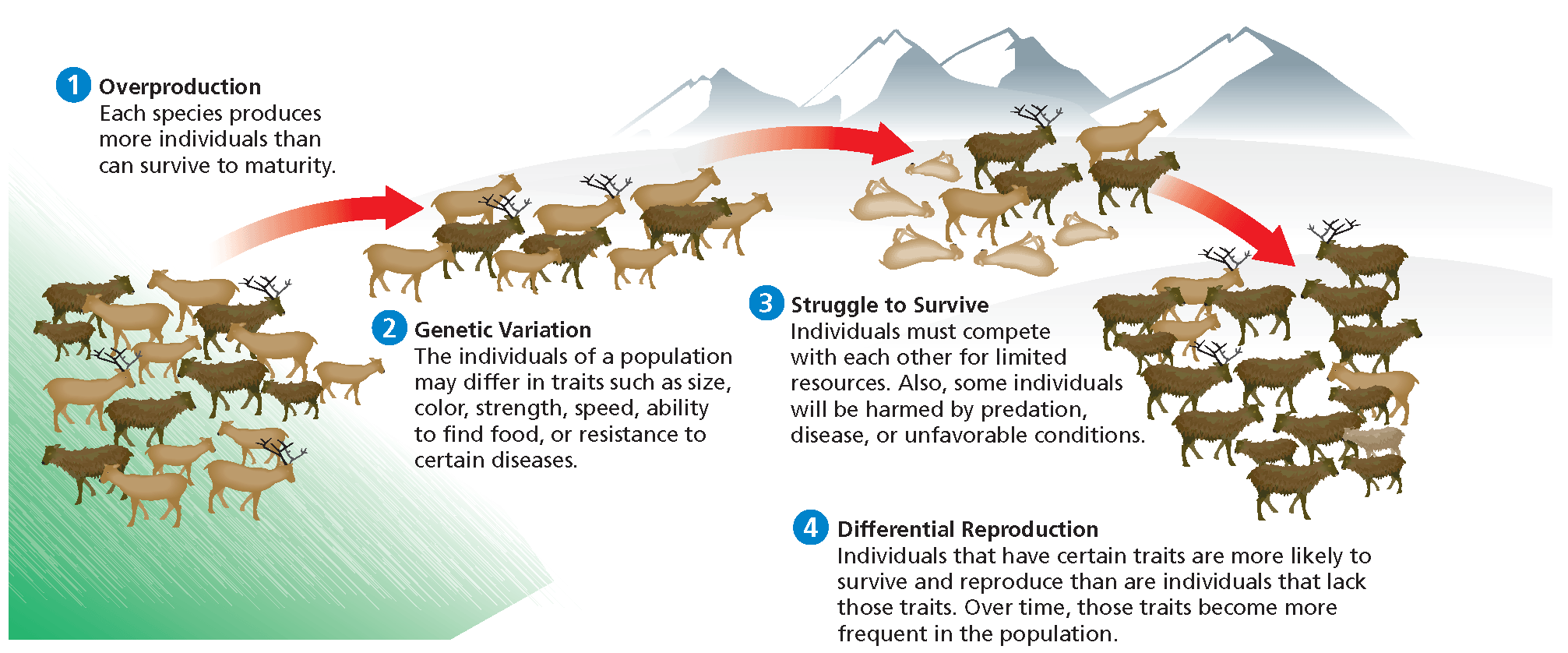
* The process of natural selection is driven by four important points that are true for all real populations:

1. All populations have genetic \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. The environment presents \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to successful reproduction.

3. Individuals tend to produce \_\_\_\_\_\_\_\_ offspring than the environment can support.

4. Individuals that are \_\_\_\_\_\_\_\_\_\_\_ able to cope with the challenges presented by their environment tend to leave more offspring than those individuals less suited to the environment do.



* In some instances, natural selection can be observed in \_\_\_\_\_\_\_\_\_\_\_ periods of time
  + When small organisms with short life spans, like \_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_ become resistant to \_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + When organisms are exposed to different \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Antibiotic Resistance**

* The lung disease tuberculosis (TB) is caused by the bacterium *\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*.
* In the 1950s, two effective \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, isoniazid and rifampin, became available to treat TB.
* In the late \_\_\_\_\_\_\_, however, \_\_\_\_\_\_\_ strains of *M. tuberculosis* that are largely or completely \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to isoniazid and rifampin appeared….

**Evolution of Antibiotic Resistance**

* Rifampin normally kills bacteria cells by binding to RNA polymerase, which will prevent \_\_\_\_\_\_\_\_\_\_\_\_\_\_
* However, TB bacteria began passing on a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that prevents rifampin from binding to the polymerase.
* So, TB bacteria with the mutation were able to \_\_\_\_\_\_\_\_\_\_\_\_\_ treatment with the antibiotic, leading to the evolution of rifampin resistance in *M. tuberculosis.*

**Evolution of Darwins Finches**

* Darwin collected 31 specimens of finches from three \_\_\_\_\_\_\_\_\_\_\_ when he visited the Galápagos Islands.
* All in all, he collected nine different species that were all very similar except for their \_\_\_\_\_\_\_\_\_
* Darwin suggested that they all evolved from an original \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ species that changed as different populations accumulated adaptations to different \_\_\_\_\_\_\_\_\_\_\_\_ sources.
* A study of the finches was carried out over \_\_\_\_ years beginning in 1973 by Peter and Rosemary \_\_\_\_\_\_\_\_\_\_\_\_ of Princeton University.
* They discovered that during drier years, birds with \_\_\_\_\_\_\_\_\_\_ beaks survived better because they could eat \_\_\_\_\_\_\_\_\_\_\_ seeds…



But during \_\_\_\_\_\_ years, birds with \_\_\_\_\_\_\_\_\_\_\_ beaks survived just as well because the seeds are \_\_\_\_\_\_\_\_\_\_\_\_\_\_

So the beaks of bird populations did \_\_\_\_\_\_\_\_\_\_\_\_\_\_ in response to the \_\_\_\_\_\_\_\_\_\_\_ food supply

**Formation of New Species**

|  |  |
| --- | --- |
| * The formation of new species, called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, occurs in \_\_\_\_\_\_\_\_\_\_\_. * The accumulation of differences between groups is called **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.** | Untitled-20 copy |

**Adaptive Radiation**

|  |  |
| --- | --- |
| When an original ancestor has diverged into many different species over time, the ancestor has gone through  a special type of divergence, called \_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_  Example…Darwin’s finches | http://www.vce.bioninja.com.au/_Media/adaptive_radiation_med.jpeg |

**Forming Subspecies**

* Divergence occurs as populations of the same species differ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because of adaptations to different living \_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + This leads to the evolution of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, which can still \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, but they represent the first steps towards speciation
* Remember, separate species cannot interbreed….
  + This might mean that they…
    - \_\_\_\_\_\_\_\_\_\_\_\_\_\_ cannot mate
    - Do not produce \_\_\_\_\_\_\_\_\_\_\_\_\_ offspring
    - Are isolated because they have different \_\_\_\_\_\_\_\_\_\_\_\_ seasons
    - Produce \_\_\_\_\_\_\_\_\_\_\_\_\_\_ offspring
* Example….The offspring of a donkey and a horse is called a \_\_\_\_\_\_\_\_\_\_\_\_
  + - This hybrid offspring is \_\_\_\_\_\_\_\_\_\_\_\_\_, so donkeys and horses are considered separate species
* Example…A similar situation applies to lions and tigers
  + - The offspring of a male lion and female tiger is called a \_\_\_\_\_\_\_\_\_\_
    - The offspring of a male tiger and female lion is called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_
* The male hybrids are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, so ligers cannot interbreed with other ligers, as tigons cannot interbreed with other tigons, so lions and tigers remain classified as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ species
* Furthermore, tigers and lions do not live in the same \_\_\_\_\_\_\_\_\_\_\_\_\_ so they don’t reproduce together \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Hardy Weinberg Principle**

* After studying Mendel’s work regarding genetics, scientists wondered if dominant traits would randomly or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ replace recessive alleles in a population
* In 1908, an English mathematician named G. H. \_\_\_\_\_\_\_\_\_\_\_\_\_ and a German physician named Wilhelm \_\_\_\_\_\_\_\_\_\_\_\_\_\_ devised a mathematical equation that allows us to keep track of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in a population

**p2 + 2pq + q2 = 1**

p2 = frequency of homozygous \_\_\_\_\_\_\_\_\_\_\_\_\_ alleles

2pq = frequency of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

q2 = frequency of homozygous \_\_\_\_\_\_\_\_\_\_\_\_\_\_ allele

\*\*\*\*\*All of the frequencies must add up to \_\_\_\_\_

**p2 + 2pq + q2 = 1**

* So, for example, the frequency of individuals with cystic fibrosis (cc) is 0.00048
  + In the equation above, where would this number be plugged in?
  + Then, you can determine the rest of the frequencies \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Hardy and Weinberg determined that allele frequencies do \_\_\_\_\_ change from population to population, unless the population is acted on by a process that \_\_\_\_\_\_\_\_\_\_\_\_ particular alleles
* So for example, a lethal dominant allele does not become more \_\_\_\_\_\_\_\_\_\_\_\_ just because it is dominant
* This discovery, called the Hardy-Weinberg \_\_\_\_\_\_\_\_\_\_\_\_\_\_, states that allele frequencies do not change unless \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ forces act on a population
* Five evolutionary forces frequently act upon the all of the genes in a population called a gene \_\_\_\_\_\_\_
* These forces are…
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Mutations:

* Mutations in \_\_\_\_\_ affect the codons in mRNA produced during \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Recall, however, that several codons code for the same amino acid, so not all mutations affect \_\_\_\_\_\_\_\_\_\_\_\_\_ synthesis
* Mutations rates in populations are usually very \_\_\_\_\_\_\_\_\_\_\_\_\_\_, but they still provide new variation in a population

Gene Flow

* Gene flow is the movement or \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of alleles into or out of a population
  + Immigration = new alleles \_\_\_\_\_\_\_\_\_\_\_ a population
  + Emigration = alleles \_\_\_\_\_\_\_\_\_\_\_\_ a population
  + Example…
  + If tall individuals leave a population, what kind of alleles will be left?

Nonrandom Mating

* Nonrandom mating occurs when organisms chose their mates based on certain \_\_\_\_\_\_\_\_\_\_\_\_
* In animals, for example, females often select males based on their….
  + \_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_
  + Ability to gather \_\_\_\_\_\_\_\_ or provide \_\_\_\_\_\_\_\_\_\_\_\_\_
* Female widowbirds prefer males with \_\_\_\_\_\_\_\_ tails. How will this change the alleles for tail length over time?

Genetic Drift

* Occurs when the allelic frequencies in a population are altered by \_\_\_\_\_\_\_\_\_\_ events
* The effects of genetic drift are seen more often in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ populations because their gene pool is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Example…Imagine that there is a bird population containing 90 red birds and 10 white birds. A hurricane blows 10 birds off of the mainland which end up on an island….
  + \_\_\_\_ of these birds are red and \_\_\_\_\_ are white
  + Due to chance, the allele frequencies of the 10 \_\_\_\_\_\_\_\_\_\_\_ birds of the new island population are drastically different from birds on the mainland
  + This type of genetic drift is often called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ effect

Natural Selection

* Favorable traits are caused by genes, but natural selection acts upon the \_\_\_\_\_\_\_\_\_\_ which is a phenotype
* So, for example, natural selection cannot eliminate a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ disease like cystic fibrosis, because heterozygous carriers have the same \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as homozygous dominant individuals
* There are also different \_\_\_\_\_\_\_\_\_\_ of natural selection that affect gene pools differently
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ selection
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ selection
  + Disruptive selection

Directional Selection

* Selects for \_\_\_\_\_ extreme version of a trait, so the population is said to be moving in one \_\_\_\_\_\_\_\_\_\_\_
* Example….Why might woodpeckers with long beaks be selected for?

Stabilizing Selection

* Occurs when individuals with \_\_\_\_\_\_\_\_\_\_\_\_ variations of a trait are selected for
* Example…spider size
  + Birds prefer to eat \_\_\_\_\_\_\_\_\_\_\_\_\_ spiders
  + Small spiders do not \_\_\_\_\_\_\_\_\_\_ prey well
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_ sized spiders survive the best

Disruptive Selection

* Where both extremes of a trait are selected for and the average is selected against
* Can lead to speciation over time
* Why might very large beaks or very small beaks be an advantage over medium sized beaks?

1. **Identify four elements in the process of natural selection**
   1. **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of offspring**
   2. **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ variation**
   3. **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to survive**
   4. **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ reproduction**
2. **Describe how natural selection has affected the bacteria that cause tuberculosis**
3. **Relate natural selection to the beak size of finches…**
   * 1. **Which type of beak enabled survival in dry environments**
     2. **Did beak type affect survival during wet/rainy years?**
4. **Summarize the process of species formation…**

**What is different about subspecies versus separate species?**

1. **Identify the Hardy-Weinberg principle…**
2. **Describe the five forces that cause genetic change in a population**
   1. **Mutations**
   2. **Gene flow**
   3. **Nonrandom mating**
   4. **Genetic Drift**
   5. **Natural Selection**
3. **Identify why selection against unfavorable recessive traits is slow**
4. **Contrast directional and stabilizing and disruptive selection**