Biodiversity & Evolution: Notes

FALL

INSTRUCTOR:

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Vocabulary / Key Terms/ Concepts	Biodiversity & Evolution
• *anatomical homology* • *ancestor* • *artificial selection* • *biodiversity* • *biogeography* • *catastrophism* • *Charles Darwin* • *cladogram*	**Student Expectations:** • Define biodiversity and explain why it is important to study and protect it. • Describe the different levels of biodiversity (species, genetic, ecosystem) and give examples of each. • Explain the theory of evolution by natural selection and how it relates to the origin of species. • Understand the concept of adaptation and give examples of how it contributes to the survival of species. • Describe the different types of evidence that support the theory of evolution (fossils, comparative anatomy, comparative embryology, molecular biology, and biogeography). • Explain the concept of speciation and give examples of how it can occur. • Understand the difference between microevolution and macroevolution and give examples of each. • Explain the process of natural selection and how it can lead to the evolution of new traits and species.

- *competition*
- *dendrogram*
- *descended*
- *developmental homology*
- *directional selection*
- *disruptive selection*
- *diversity*
- *environment*
- *evolution*
- *fossil record*
- *gene flow*
- *gene frequency*
- *genetic drift*
- *genus*
- *gradualism*

- Understand the importance of genetic variation in natural selection and how it can lead to the adaptation of populations to changing environments.
- Describe the impact of human activities on biodiversity and the environment, and suggest ways to mitigate these impacts.

BIOLOGICAL CONCEPTS

I. Biodiversity

- **A. Definition of biodiversity**
- **B. Importance of biodiversity**
- **C. Factors that affect biodiversity**

II. History of Evolutionary Theory

- **A. Pre-Darwinian Theories**
- **B. Charles Darwin and The Origin of Species**
- **C. Modern Synthesis**

III. Evidences for Evolution

- **A. Fossil Record**
- **B. Comparative Anatomy**
- **C. Embryology**
- **D. Molecular Biology**
- **E. Biogeography**

IV. Natural Selection

- **A. Definition of Natural Selection**
- **B. Mechanisms of Natural Selection**

- *habitat*
- *homologous structures*
- *inherited variation*
- *isolation*
- *molecular homology*
- *native species*
- *natural selection*
- *non-random mating*
- *offspring*
- *phylogenetic*
- *phylogram*
- *population*
- *predator*
- *prey*
- *punctuated equilibrium*

C. Evolution by Natural Selection

V. Types of Selection

A. Directional Selection

B. Stabilizing Selection

C. Disruptive Selection

D. Sexual Selection

VI. Reasons for Adaptation and Speciation

A. Adaptive Radiation

B. Convergent Evolution

C. Divergent Evolution

D. Genetic Drift

E. Gene Flow

F. Mutation

I. _____

A. Definition of biodiversity

1. _____ refers to the _____ of living _____ that exist on **Earth**.
2. It includes:
   - **a. diversity in _____**
   - **b. _____**
   - **c. _____ .**

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- *recombination*
- *reproduce*
- *reproductive success*
- *species*
- *stabilizing selection*
- *stasis*
- *survive*
- *taxon/taxa*
- *taxonomic*
- *uniformitarianism*
- *variation*
- *vestigial structures*

B. Importance of biodiversity

1. Biodiversity is **_____** for the **_____** and **_____** of ecosystems. It provides **numerous** ecosystem **services**:

a. such as air and water _____

b. nutrient _____

c. _____ formation.

2. Biodiversity also has **economic**, **cultural**, and **aesthetic** value.

a. Biodiversity has **_____** value because:

1.) it provides a wide range of goods and services that are essential for human survival and well-being. For example, many medicines are derived from plants and animals, and a diverse ecosystem provides a variety of ecosystem services such as pollination, water filtration, and soil fertility.

b. Biodiversity also has **_____** value as it is often intertwined with the cultural identity and practices of local communities.

1.) Many cultures around the world have developed unique relationships with their local ecosystems, which are reflected in their traditional knowledge and practices related to agriculture, hunting, and gathering.

2.) Biodiversity also provides inspiration for art, music, and literature, and is an important part of the world's cultural heritage.

c. Finally, **biodiversity** has **_____** value as it provides beauty and inspiration for people.

1.) Many people derive pleasure from observing and experiencing the natural world, and the

diversity of life forms found in different ecosystems adds to the richness and diversity of our experiences.

C. Factors that affect biodiversity

1. including**:**

a. _____

b. _____

c. _____

d. _____ **of**

_____

e. and_____

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II. History of Evolutionary _____

A. Pre-Darwinian Theories

1. _____ - proposed by Jean-Baptiste Lamarck in the early 19th century, this theory suggested that organisms could acquire new traits during their lifetime and pass them on to their offspring. Lamarckism also proposed that organisms could evolve in response to environmental changes.

2. _____ - this theory, proposed by Georges Cuvier in the late 18th and early 19th centuries, suggested that the Earth's history was marked by catastrophic events that caused the extinction of many species. According to this theory, new species were created to replace those that had gone extinct.

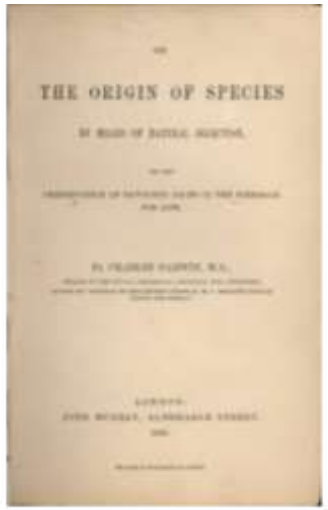
3. **_____** - proposed by geologist Charles Lyell in the early 19th century, this theory suggested that geological processes that shaped the Earth's surface were slow and gradual, occurring over long periods of time. Lyell argued that the Earth was much older than previously thought, and that its history was marked by gradual, rather than catastrophic, changes.
4. **Natural _____** - this theory, popular in the 18th and early 19th centuries, held that the complexity and beauty of living organisms could only be explained by the existence of a divine creator.

B. Charles Darwin and The _____ of _____

1. Charles Darwin is credited with proposing the theory of evolution by natural selection.
2. He published his book, **The Origin of Species**, in 1859, which presented evidence for evolution and explained the mechanism of natural selection.

C. _____ Synthesis

1. The **modern synthesis**, also known as the **neo-Darwinian synthesis**, is a **combination** of **Darwin's theory** of evolution by **natural selection** and **modern genetics.**
2. It explains how variation and natural selection can lead to evolutionary change.
3. **_____ and _____ -** the modern synthesis recognized that genetic variation arises from mutation and recombination, which provides the raw material for natural selection to act upon.
4. **_____ genetics -** the modern synthesis integrated



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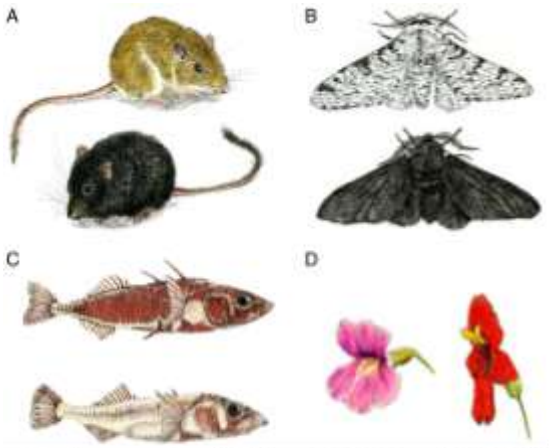
the study of genetic variation within populations with Darwin's theory of natural selection. This allowed for a quantitative understanding of how evolution occurs in populations.

5. **_____** - the modern synthesis emphasized the importance of gradual change over long periods of time in the evolution of species.
   - **a.** Proposed as alternative to Gradualism - **_____ _____**
     - **1.)** Suggests that species may remain relatively stable for long periods of time, or exhibit stasis, with little change in their morphology or behavior.
     - **2.)** However, when a species does undergo evolutionary change, it does so rapidly and in a punctuated manner, rather than gradually over time.
6. **The _____ of natural selection -** the modern synthesis emphasized the central role of natural selection in driving evolutionary change. It recognized that natural selection acts on individual organisms, but its effects are observed at the level of populations over time.
7. **The _____ of adaptation -** the modern synthesis clarified the concept of adaptation, which refers to traits that increase an organism's **fitness** in a particular environment.
   - **a.** Adaptation occurs through the process of natural selection, which selects for traits that confer a fitness advantage.



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III. _____ for Evolution

A. _____ Record

1. The fossil record is the collection of all known fossils,

which are the preserved remains or traces of ancient organisms.

a. _____

b. _____

c. **Imprints** of feathers, plants

2. It provides a _____ record of the _____ of life on Earth, and is an important source of _____ for the theory of evolution.

3. The fossil record is _____ complete, as it only represents a small fraction of all the organisms that have ever lived on Earth.

a. The chances of an organism becoming a fossil are relatively low, as it requires the organism to be buried in sediment quickly after death and for the sediment to be preserved and later exposed by geological processes.

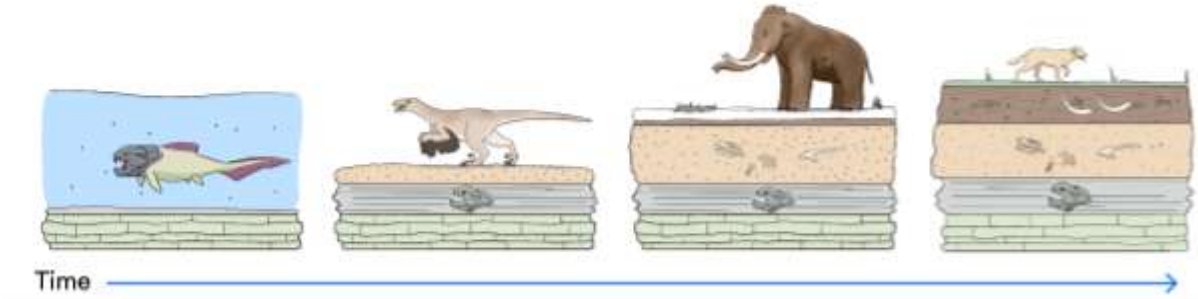
b. As a result, many organisms are not fossilized, and the fossil record may be biased towards organisms that lived in environments that were conducive to fossilization, such as those with hard shells or bones.

4. Despite its incompleteness, the fossil record provides important evidence for the theory of evolution. One of the most important aspects of the fossil record is the presence of _____ fossils.

a. _____ fossils are fossils that show intermediate forms between two different species, or between a species and its ancestors.

b. These fossils provide evidence of **evolutionary** _____ over time and demonstrate the _____ nature of evolutionary transitions.

5. **The Law of _____** is a geological principle that states that in undisturbed rock layers, the _____ rocks are on the **bottom** and the _____ rocks are on **top**.
   - **a.** This principle is important for understanding the **relative ages** of fossils found in different **layers** of rock.
   - **b.** By examining the layers of rock and the fossils found within them, scientists can determine the relative ages of the fossils and make _____ about the order in which different species evolved.



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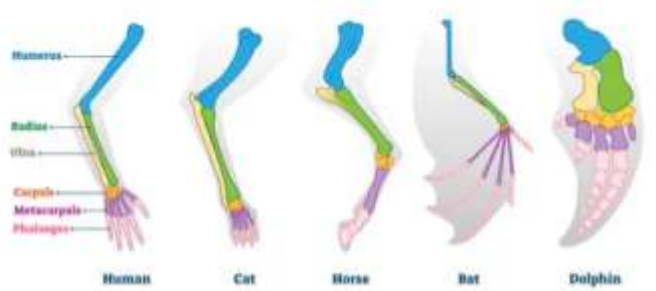
B. _____ Anatomy

1. _____ **anatomy** compares the anatomical structures of different organisms to identify similarities and differences. It provides evidence for common ancestry and evolutionary relationships between different groups of



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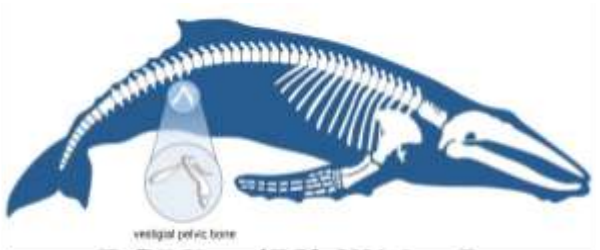
organisms.

a. _____

1.) _____ refers to similarities in the _____ of **different** organisms that are due to their _____ _____ .

2.) Homologous structures have _____ underlying _____ and development, but may have _____ **functions** in _____ species.



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b. _____ **structures**

1.) Vestigial structures are _____ that have **no known** _____ in an organism but are _____ of structures that were **functional** in _____ species.

2.) Vestigial structures provide _____ of the **evolutionary** _____ of an organism.

c. _____

1.) _____ structures are structures that have a _____ **function** in different species but have _____ underlying _____ and development.

2.) Analogous structures are the result of _____ evolution, where different

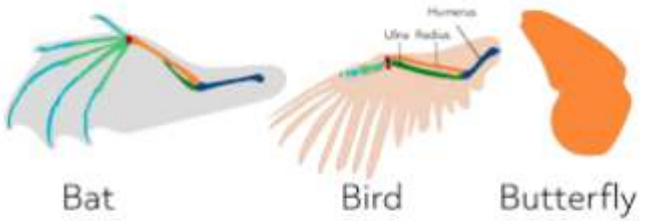
species evolve similar structures _____ in response to _____ **environmental** pressures.

d. Examples

1.) Examples of _____ structures include the forelimbs of mammals, birds, and reptiles.

2.) Examples of _____ structures include the human appendix.

3.) Examples of _____ structures include the wings of birds and bats.



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e. Significance

1.) Comparative anatomy is an important source of evidence for the theory of evolution, as it provides clues about the evolutionary history of organisms.

C. _____

1. _____ compares the development of _____ of **different** organisms to identify _____ and **differences**.

2. It provides evidence for _____ _____ and **evolutionary**

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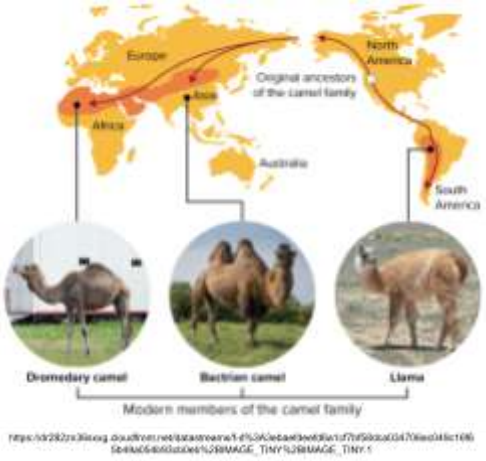
relationships between different groups of organisms.

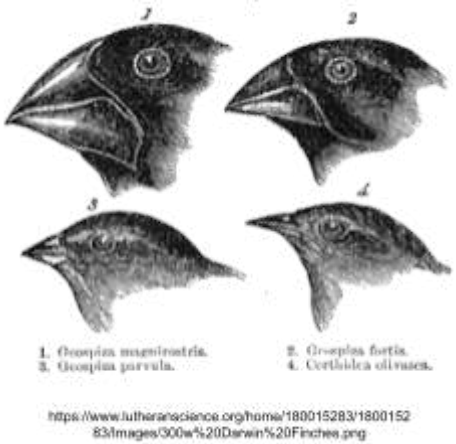
D. _____ **Biology**

1. **Molecular biology** compares the _____ and _____ **sequences** of _____ organisms to identify _____ and differences.
2. It provides evidence for _____ _____ **and** _____ **relationships** between different groups of organisms.



E. _____

1. _____ compares the _____ of organisms in _____ **r**egions to identify similarities and differences.
2. It provides evidence for how **organisms** have _____ and _____ in response to **changes in their environment.**



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IV. _____ _____

A. Definition of Natural Selection

1. **Natural selection** is the process by which organisms that are better _____ to their

_____ are more likely to _____ and _____ .

B. _____ of Natural Selection

1. The mechanisms of natural selection include **_____ , _____ , and differential _____ and _____ .**

a. Variation:

1.) **_____** refers to the fact that **individuals** within a **species differ** from one another in their traits or **characteristics**.

2.) These **differences** can be caused by **genetic factors, such as:**

a.) **_____**

b.) **by environmental factors,** such as: differences

i.) differences in **_____**

ii.) exposure to **_____ .**

b. _____ :

1.) **Inheritance** refers to the **_____** of genetic **_____** from parents to **offspring.**

2.) **_____** **i**nherit **some** of the **_____** of their **_____** through the **passing** of genetic material from one **_____** to the **next**.

c. Differential _____ and _____ :

1.) **Natural selection** occurs when **_____** with certain **traits** are

_____ **likely** to _____ and _____ than individuals with **other traits.**

2.) **Traits** that _____ an individual's **chances** of _____ and **reproduction** will tend to be _____ on to the next _____ , while **traits** that **decrease** an individual's chances of **survival** and **reproduction** will tend to be _____ .

d. _____ **:**

1.) Over time, natural selection **leads** to **changes** in the **characteristics** of a **population**, as _____ traits become **more** common, while _____ traits become **less** common.

C. _____ **by Natural Selection**

1. _____ by natural selection occurs when the _____ of certain _____ in a **population** changes over time due to _____ reproductive _____ .

2. _____ with **traits** that are better **adapted** to their environment ar**e more likely** to **survive** and **reproduce,** _____ on those advantageous **traits** to their _____ .

3. Over time, this can lead to the _____ of **new** _____ .

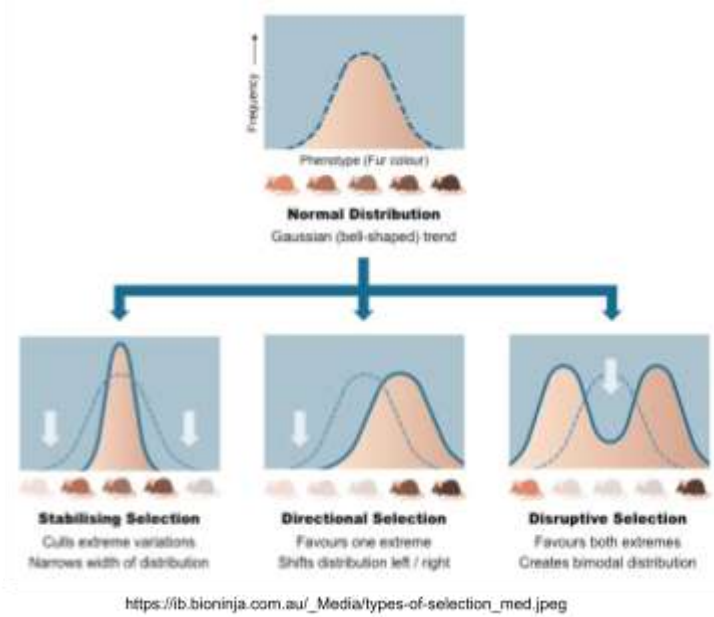
V. Types of _____

A. _____ Selection

1. _____ **selection** occurs when individuals with _____ **traits** have a _____ fitness than those with **average** traits.
2. This can lead to the **evolution of new traits** in a **population.**

B. _____ Selection

1. _____ **selection** occurs when individuals with _____ **traits** have a _____ fitness than those with _____ **traits.**
2. This can lead to the **maintenance of** _____ **traits** in a **population.**



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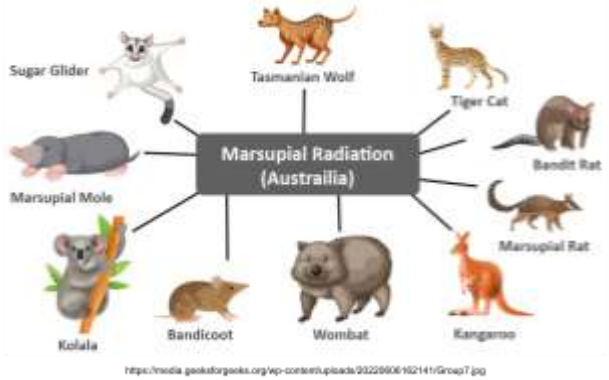
C. _____ Selection

1. _____ **selection** occurs when individuals with _____ **traits** at _____ ends of a spectrum have a _____ **fitness** than those with _____ **traits.**
2. This can lead to the evolution of **new traits** and the **formation** of **new species.**

D. _____ Selection

1. _____ **selection** is a type of natural selection that occurs when _____ with certain **traits** have a _____ **reproductive success** than others.
2. This can lead to the _____ of **exaggerated traits** that are used in _____ or **competition f**or **mates**.

VI. Reasons for _____ and _____



A. _____ _____

1. _____ **radiation** occurs when a **sin**_____ **gle** ancestral species _____ into _____ **new** _____ in response to different **ecological** _____ **.**

   a. _____ **:** is the **role** or **position** that an organism occupies within its **environment,** including its **interactions** with other _____ and _____ components of the _____ **.**

   1.) It encompasses the organism's use of resources, such as food and habitat, as well as its _____ with other species, including predators, prey, and competitors.

   2.) The niche of an organism is defined by a complex set of environmental factors, such as

_____ , _____ , and availability of _____ , and can be very specific to a particular location or ecosystem.

3.) An organism's niche can have a significant impact on its survival and reproductive success, as it determines the resources that are available to the organism and the interactions that it has with other species in the ecosystem.

2. This can lead to the formation of **new species** and the development of **diverse ecosystems.**

B. _____ Evolution

1. _____ evolution occurs when _____ **species** evolve _____ traits due to _____ **selective pressures** in their environment**.**

2. This can lead to the **development** of _____ **structures** in different species**.**

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3. Examples:

a) Wings in birds, bats, and insects:

- Birds, bats, and insects all have wings that allow them to fly, but the underlying anatomy and development of their wings is very different.
- The wings of birds are modified forelimbs, while the wings of bats are modified hands with elongated fingers, and the wings of insects are composed of thin, membranous structures attached to the body by flexible joints.

b) Thorns in cacti and acacias:

- Cacti and acacias are both plants that evolved in environments with intense grazing pressure.

- Both types of plants have evolved thorns to deter herbivores and protect their leaves and stems.

c) Eyes in cephalopods and vertebrates:

- Cephalopods, such as squid and octopuses, have evolved complex, camera-like eyes that are structurally and functionally similar to those of vertebrates.
- This convergence is thought to have occurred because cephalopods and vertebrates share a similar need for high-quality visual information in order to navigate their environments.

d) Echolocation in bats and whales:

- Bats and toothed whales both use echolocation to navigate and locate prey in their environments.
- Despite the fact that bats and whales are mammals, they have independently evolved similar mechanisms for producing and detecting echolocation signals.

C. _____ Evolution

1. _____ evolution occurs when a single **_____ species diverges** into **_____ new species** in response to **_____ selective pressures** in their environment.

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2. This can lead to the formation of **new species** and the **development** of diverse **ecosystems.**

3. Examples:

a) Darwin's finches:

- Darwin's finches are a group of 13 species of finches found on the Galápagos Islands.
- Each species has a unique beak shape that is adapted to its specific food source, which has led

to the evolution of different feeding behaviors and niches within the group.

b) Dogs:

- Domestic dogs have evolved from a common ancestor, the gray wolf, but have been selectively bred for different traits by humans.
- This has led to the evolution of many different dog breeds, each with distinct physical and behavioral characteristics.

c) African elephants:

- African elephants are the largest land animals on Earth and are divided into two species, the savanna elephant and the forest elephant.
- These two species have evolved different physical characteristics and behaviors that are adapted to their different habitats.

d) Anole lizards:

- Anole lizards are a group of more than 400 species found throughout the Americas.
- Despite their close evolutionary relationship, different species have evolved different physical characteristics, such as body size and coloration, as a result of selective pressures such as predation and competition.

D. _____ _____

1. **_____ drift** is the **_____ fluctuation** of **allele frequencies (_____)** in a **population** due to **chance** events**,** such as genetic **_____** or fluctuations in **population size.**
2. **It can lead to the loss of genetic diversity and the formation of new species.**
3. **Examples:**

   a) _____ effect:

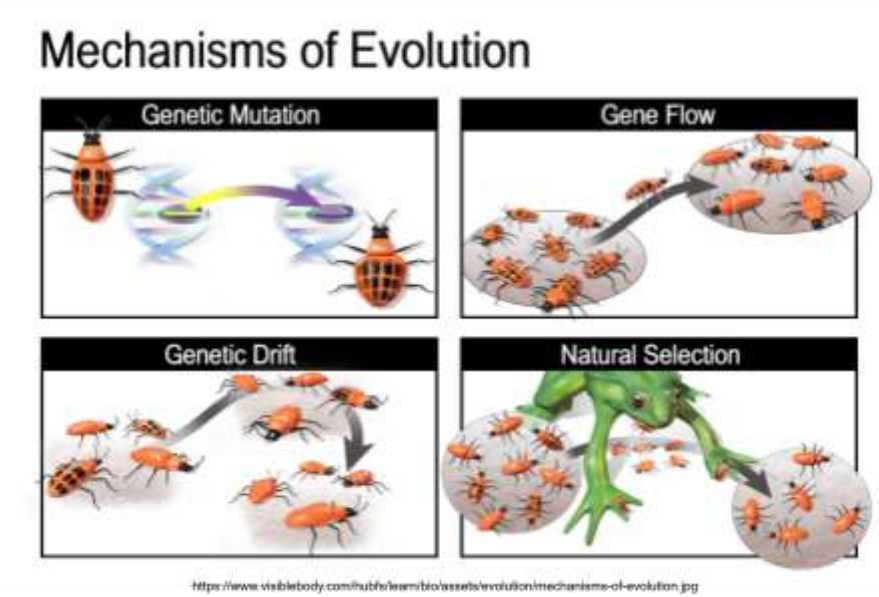
- **Occurs when a small group of individuals from a larger population colonizes a new area.**
- Only a subset of the genetic diversity of the original population is brought with them.
- The genetic makeup of the new population may differ significantly from that of the original population due to random sampling of alleles.
- **Example**: **The Amish population in the United States.**

b) _____ effect:

- **Occurs when a population undergoes a sharp reduction in size due to a catastrophic event.**
- The genetic diversity of the population can be severely reduced.
- Certain alleles may become more or less common in the population due to chance.
- **Example**: **The northern elephant seal.**

c) _____isolation:

- **Occurs when populations become geographically isolated from one another.**
- Populations can undergo genetic drift due to differences in selective pressures or random



fluctuations in allele frequencies.

- Over time, these differences can lead to the emergence of new species.
- **Example**: **The Galapagos finches.**

E. Gene _____

1. **_____** is the **_____** of **_____** between **_____** **populations** due to **_____** or other means.

2. It can **_____** **genetic diversity** within a **population** and can **_____** the formation of **new species.**

3. Examples:

a) _____ :

- Occurs when **individuals move** from one **population** to **another** and **breed** with members of the **new** population.
- **Introduces** new **alleles** into the **gene pool** of the population.
- Can **increase** genetic **diversity** and may lead to **new adaptations** in the population.
- **Example: The brown anole lizard in Florida.**

b) _____ :

- Occurs when **pollen** from one population of plants is **carried** to **another** population by **wind**, **insects**, or other means.
- Leads to **gene flow** between populations.
- **Introduces** new **alleles** into the **gene pool** of the population.
- Can increase genetic diversity and may lead to the emergence of new species with novel traits.
- **Example: The wild sunflowers of North America.**

c) **_____ gene flow:**

- Occurs when humans **intentionally** or **unintentionally introduce** new **alleles** into populations of **plants** and **animals** through activities such as **agriculture**, **domestication**, and **transportation**.
- Can lead to gene flow between populations that would not have otherwise occurred.
- Introduces new alleles into the gene pool of the population.
- Can lead to changes in the genetic makeup of the population over time.
- **Example: The domestication of crops such as maize and wheat.**

F. _____

1. **_____** is the process by which **genetic (_____)** information is **_____** or **changed**.
2. It can lead to the **development** of new **_____** and the formation of **new _____** over time.
3. **Examples:**
   a) **Antibiotic resistance in bacteria:**
      - Bacteria can develop resistance to antibiotics through mutations that confer resistance to the drug.
      - **Accumulation** of these **mutations** can lead to the **emergence** of **new** strains of **bacteria** that are **resistant** to multiple **antibiotics**.
      - **Example: Methicillin-resistant Staphylococcus aureus (MRSA).**
   b) **The evolution of lactose tolerance in humans:**
      - The ability to digest lactose into adulthood is due to a mutation in the LCT gene that occurred

in humans around 7,000-10,000 years ago.

- This **mutation** allowed **people** who **possessed** it to continue **producing** the **lactase enzyme**, which **breaks** down **lactose**, into adulthood.
- **Example: Some populations in Europe and Africa.**

c) The evolution of coloration in peppered moths:

- During the industrial revolution in England, **pollution** caused many of the **trees** that the moths rested on to become **darkened** by soot.
- This led to an **increase** in the **frequency** of **dark-colored moths**, as they were better **camouflaged** on the darkened trees.
- This **adaptation** was due to a **mutation** in a **gene** that **regulates** the production of **pigments** in the moth's wings.

d) The evolution of the arctic fox:

- **Arctic foxes** have **adapted** to their **cold** and snowy environments through a **mutation** in a gene that **regulates** the **expression** of their **fur**.
- In winter, their **fur** turns **white** to blend in with the snow, while in **summer** it turns **brown** to blend in with the tundra.
- This **adaptation** allows them to **avoid predation** and **hunt** more **effectively**.

Notes Summary	
