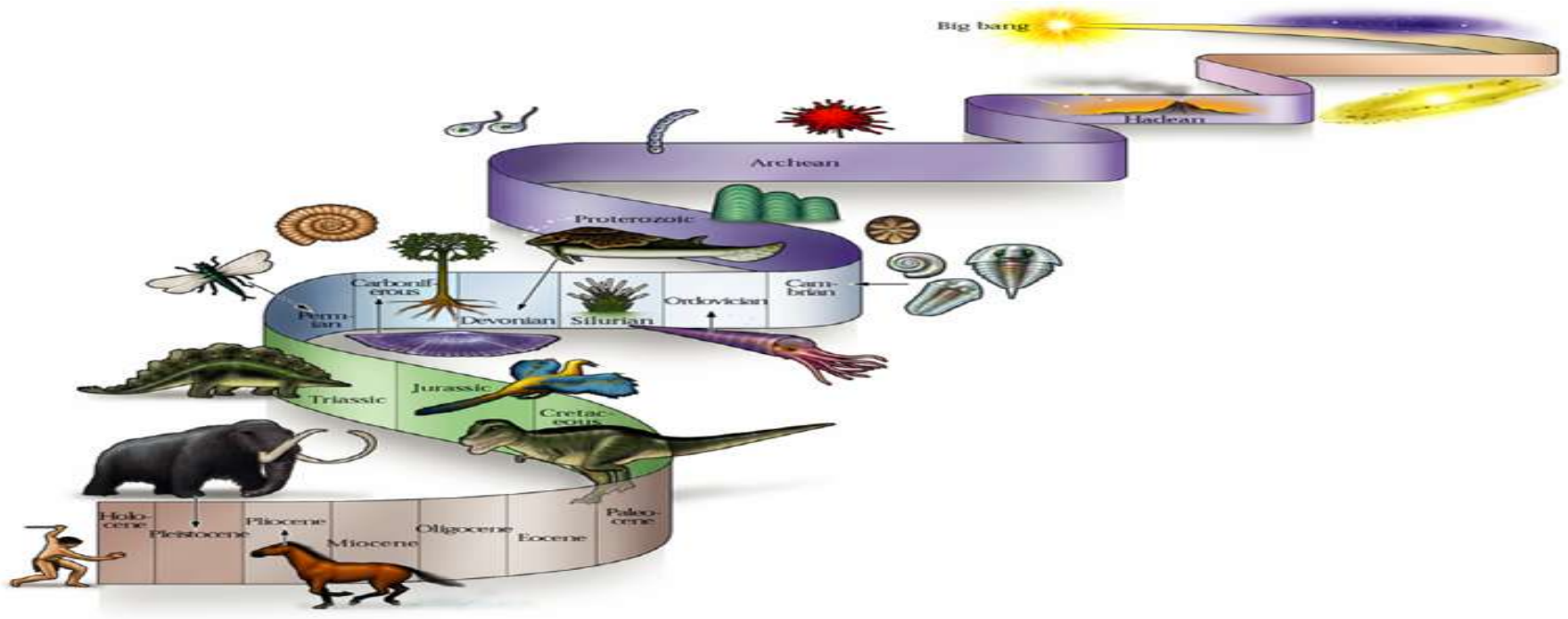
Domain V Review

Evolution

What is Evolution?

- The Theory of Evolution explains the process by which modern organisms have descended from ancient organisms.



History behind the theory

- Proposed by Charles Darwin (Darwinism) and Alfred Wallace in 1858
- Earlier concepts of evolution
  - Georges Louis Leclerc de Button- challenged many of the accepted ideas of the day. Proposed that species shared ancestors instead of rising separately.
  - Eramus Darwin- Darwin's grandfather. Proposed that all living things were descended from a common ancestor and that more complex forms of life arose from less complex forms.
  - Jean-Baptiste Lamarck (Lamarckism)-Proposed that by selective use or disuse of organs, organisms acquired or lost certain traits during their lifetime. This is known as the Inheritance of Acquired Traits
  - Thomas Malthus (economist)- Reasoned that if the human population continued to go unchecked, sooner or later there would be insufficient living food and space for everyone.
  - George Cuvier- Proposed the theory of catastrophism that natural disasters such as floods and volcanic eruptions have happened often during Earth's long history.
    - These events shaped landforms and caused species to become extinct in the process

History behind the theory cont.

- James Hutton (geologist)- Proposed that changes he observed in landforms resulted from slow changes over a long period of time, known as gradualism. 
- Charles Lyell (geologist)- Expanded Hutton's theory of gradualism into the theory of uniformitarianism. Proposes that the geologic process that shapes Earth are uniform through time.
  - Observed processes that made small changes in Earth.

Natural Selection vs. Artificial Selection

- Artificial Selection- The process by which humans change a species by breeding it for certain traits.
  - Humans determine which traits are favorable and breed individuals that show those traits.

- Natural Selection- The mechanism by which individuals that have inherited beneficial adaptations produce more offspring than do other individuals.
  - The environment is the selective agent, therefore, characteristics are selected only if they give advantages to individuals in the environment as it is right now.

The Process of Evolution by Natural Selection

- The Struggle for Existence
  - Proposed by Thomas Malthus
  - Members of each species compete regularly to obtain food, living space, and other necessities of life
    - These resources are limiting factors
    - Disease and limited food supply keeps populations small.
- Populations consist of all the individuals of a species that live in an area.

The Process of Evolution by Natural Selection

- Variation
  - Differences among individuals result from differences in the genetic material of the organisms, whether inherited from a parent or resulting from a genetic mutation.
- Overproduction
  - More organisms than can survive are produced, this increases the chance that some will survive.
- Adaptation
  - Certain variations allows an individual to survive better than other individuals it competes against in its environment.
- Descent with modifications
  - Natural selection will result in species with adaptations that are well suited for survival and reproduction. Offspring will have these traits it environmental conditions do not change.

The Process of Evolution by Natural Selection

- Survival of the Fittest
  - Individuals not suited to their environment either die. Individuals that are better survive and reproduce
  - Over time natural selection results in changes in the inherited characteristics of a population. These changes increase a species' fitness in its environment

Chapter 15

Words to know

- Fitness is the ability of an organism to survive and reproduce in its specific environment
- An Adaptation is any inherited characteristic that increased an organisms chance of survival
  - Adaptations Can Be:
    - Physical
  - Speed, Camouflage, Claws, Quills, etc.
    - Behavioral
  - Solitary, Herds, Packs, Activity, etc.

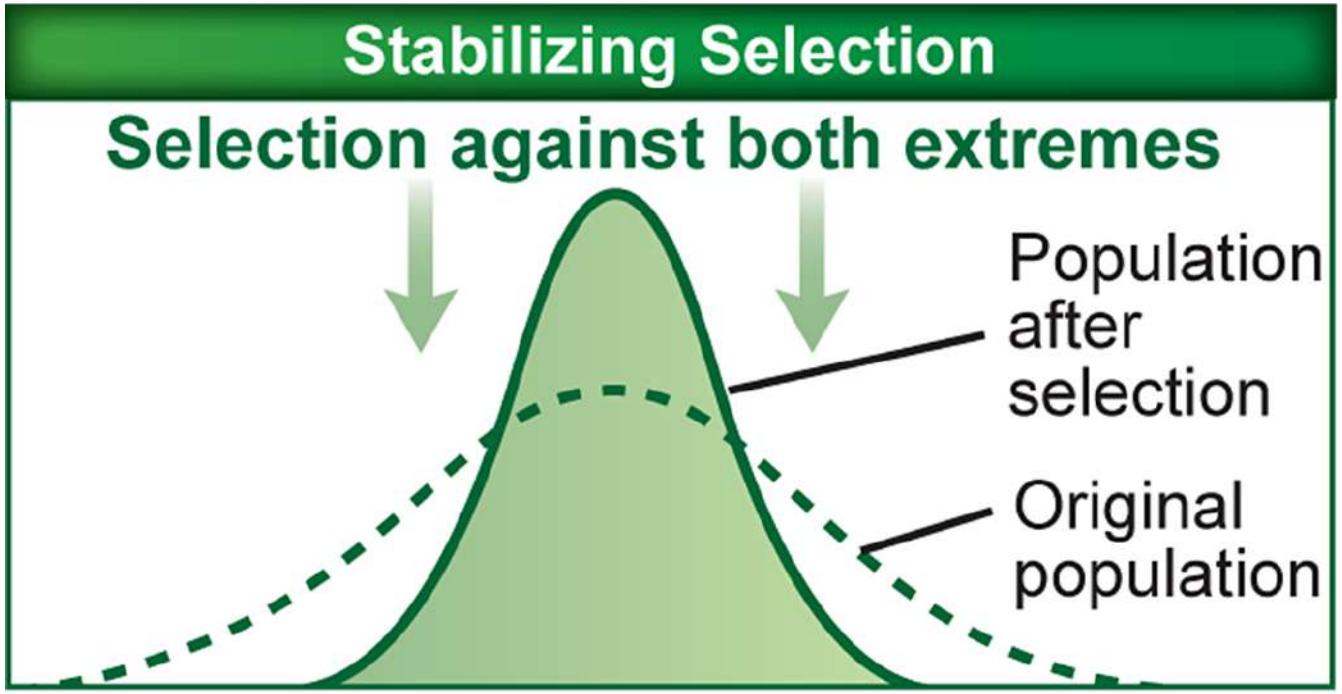
Evidence for Evolution

Evidence For Evolution

- Fossil Evidence
  - Fossils in different layers of rock showed evidence of gradual change over time
- Geographical Evidence
  - Island species most closely resemble nearest mainland species
- Embryological Evidence
  - All organisms look similar during early (embryo) development- evolution from a distant common ancestor, creates diverse organisms
- Anatomical Evidence
  - Species contain remnants of structures or organs that have no function. These are known as vestigial structures.
  - Homologous and Analogous Structures  
- Molecular Evidence
  - Two closely related organisms will have similar DNA sequences.

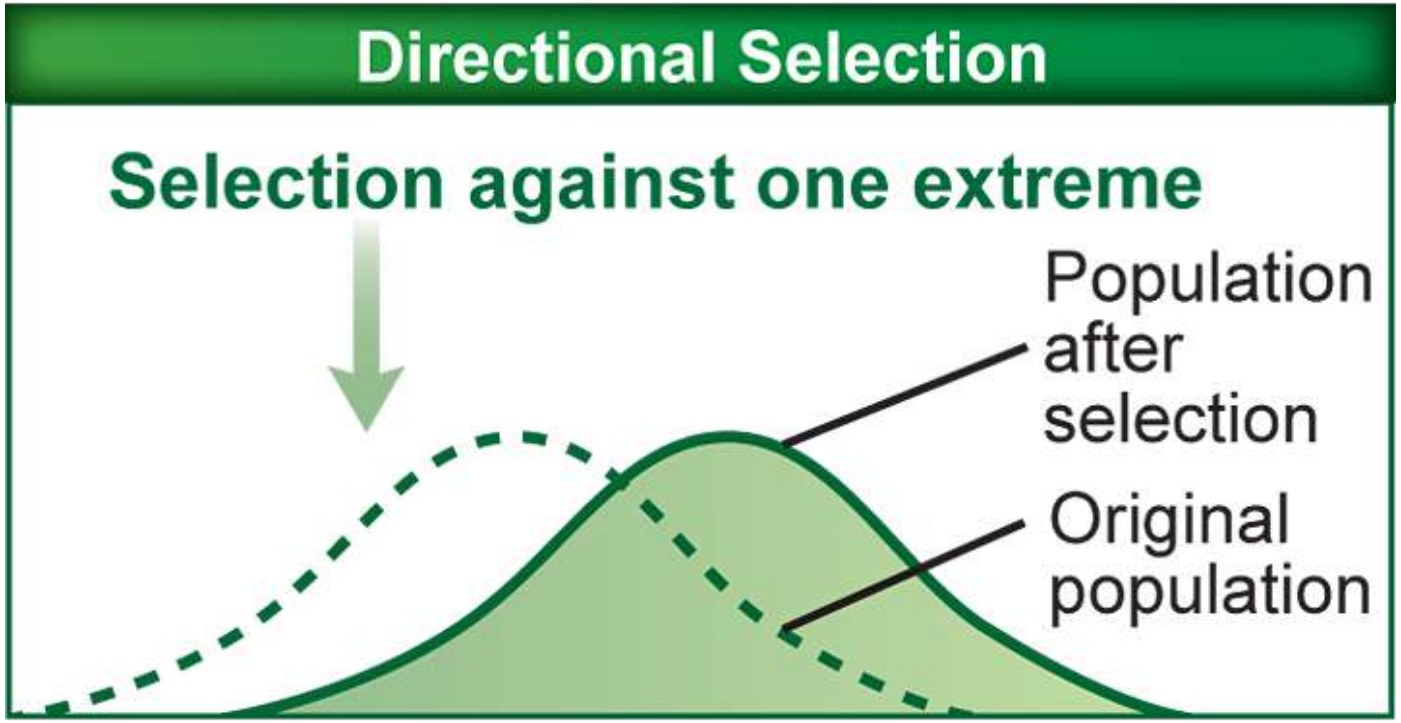
Stabilizing selection

- Also called normalizing selection
- The center of the curve remains in its current position
- Individuals near the center of a distribution curve have higher fitness than those at either end



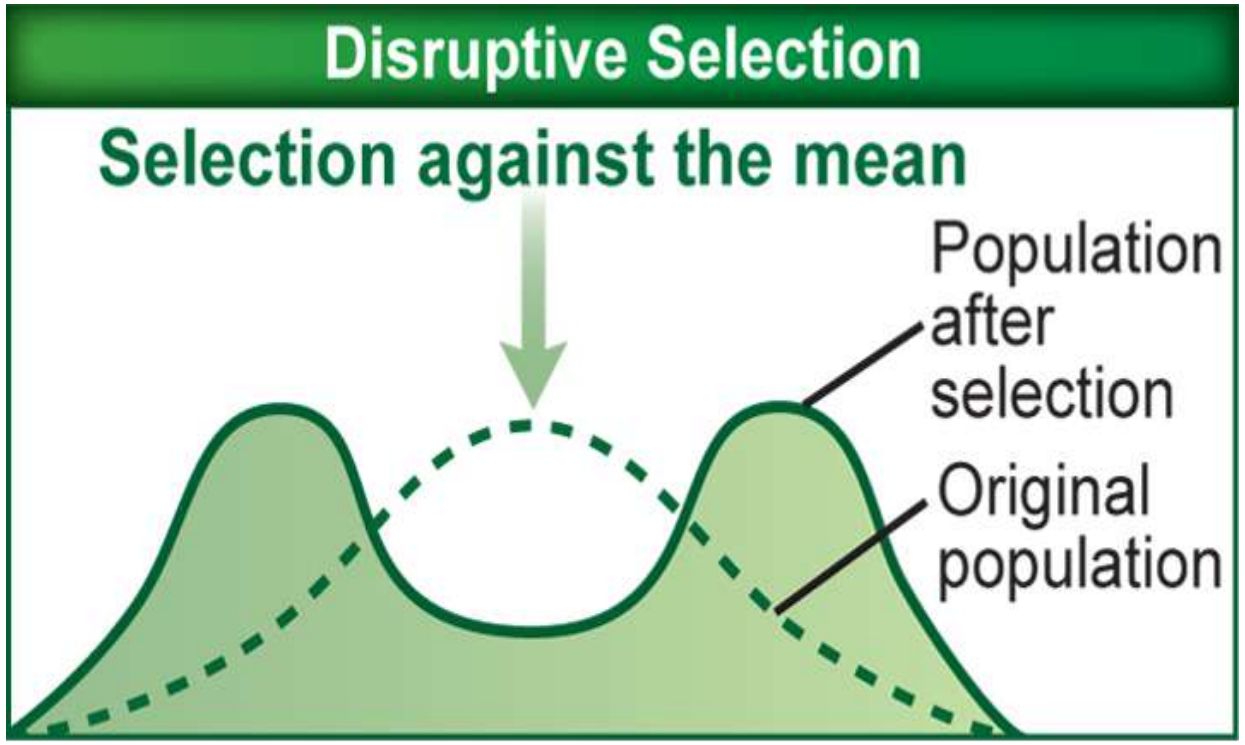
Directional selection

- Change from one phenotype to another one
- When environmental conditions favor the survival of individuals with a particular trait, there is an increase in the frequency of that trait



Disruptive selection

- Also known as diversifying selection
- No single phenotype is more successful than any other
- The intermediate between two types may disappear
- Results in two or more groups that are best fit for survival

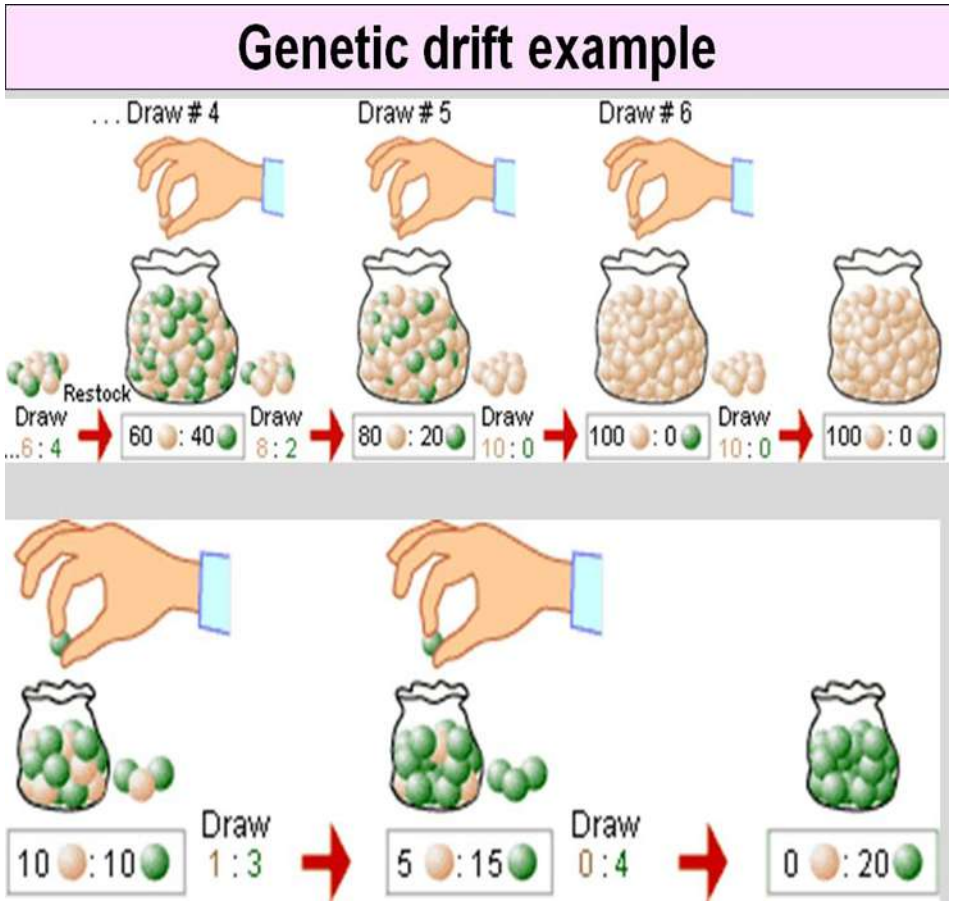


Biological resistance

- Organisms that are naturally resistant to something (a disease, an insecticide, etc.) survive and pass that trait to their offspring
- This happens more quickly in populations that have short reproductive or life cycles
  - Pesticide resistance:
    - A farmer sprays a field with a pesticide killing almost all of a species of beetle
    - Some of the beetles survive because of a natural resistance to the pesticide
    - Each year there are more beetles that have the pesticide resistant gene until the pesticide is no longer considered effective

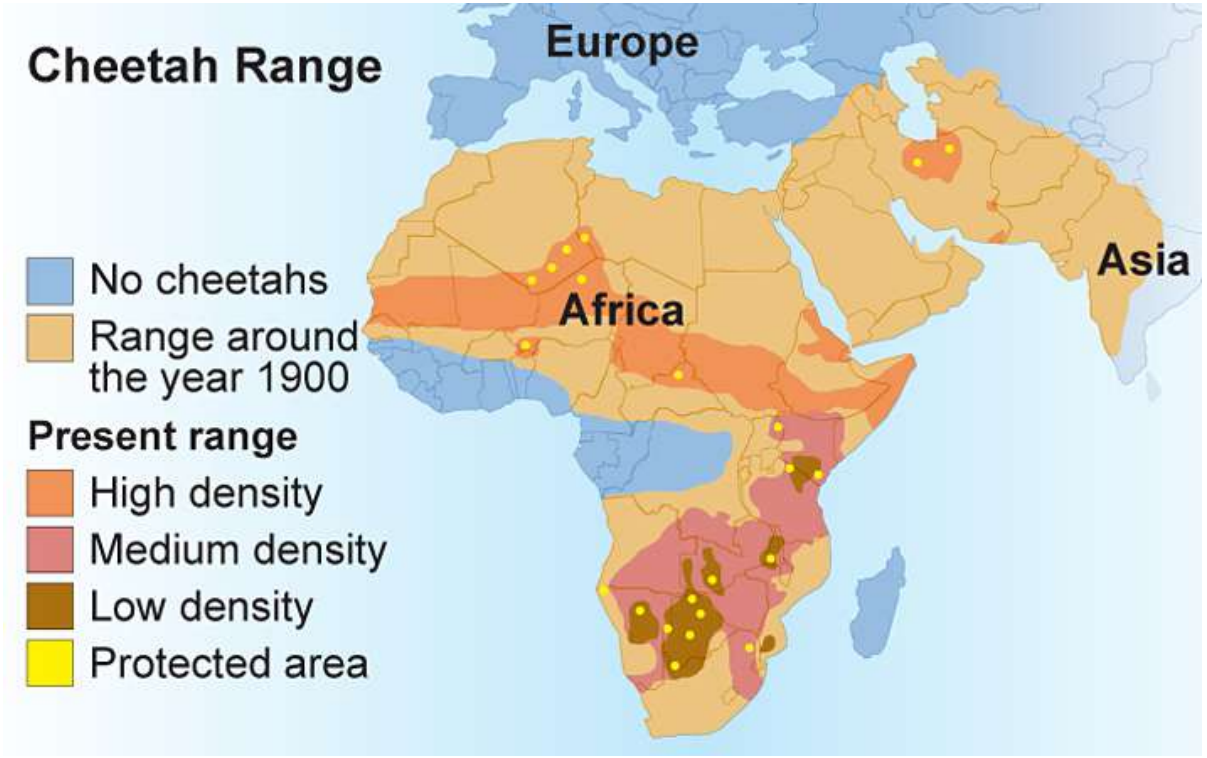
Genetic Drift

- In small populations, an allele can become more or less common simple by chance.
- Causes a loss in genetic diversity within a population.
- In smaller populations, the effects become more pronounced, and the chance of losing an allele becomes greater.



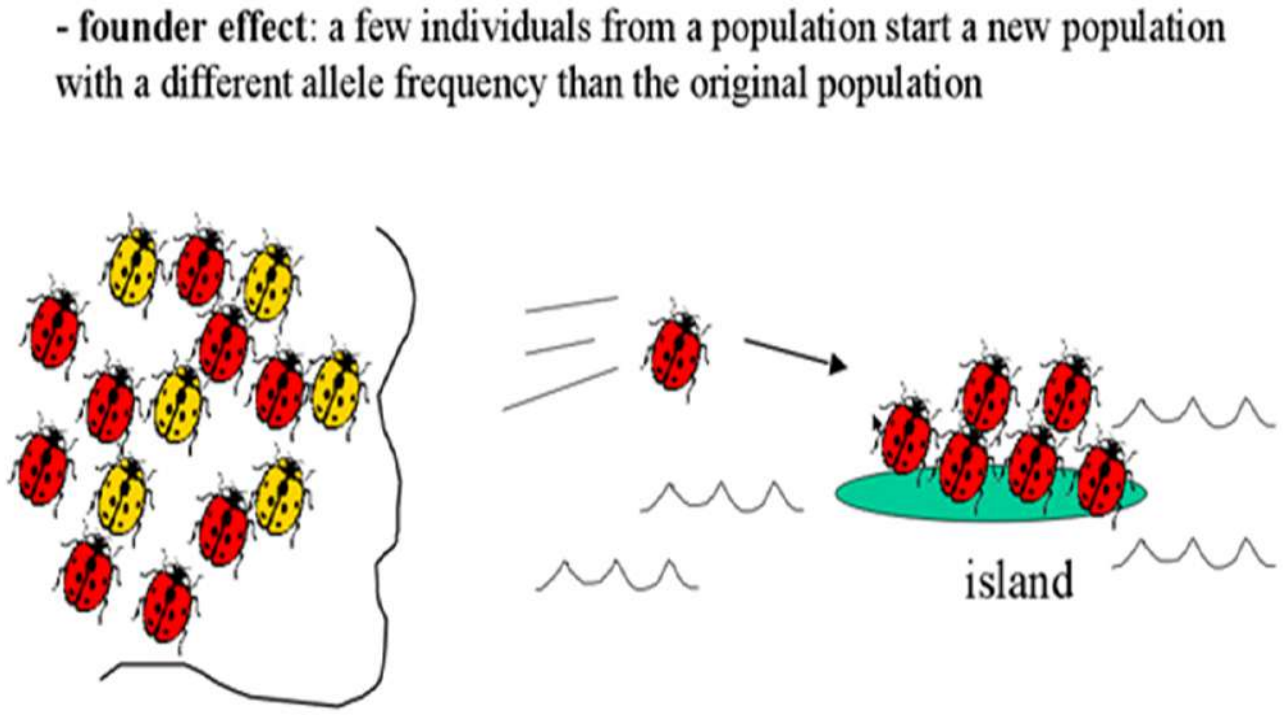
Bottleneck Effect

- A genetic drift event that occurs after an event that greatly reduces the size of a population.
- Leaves only a few survivors in a population, then it rebounds.



Founder Effect

- A situation in which allele frequencies change as a result of migration of a small subgroup of a population.
- Alleles that were uncommon in the original population might be common in the new population.



Genetic equilibrium (Hardy – Weinberg)

- Five conditions are required to maintain genetic equilibrium from generation to generation

The Hardy-Weinberg Principle

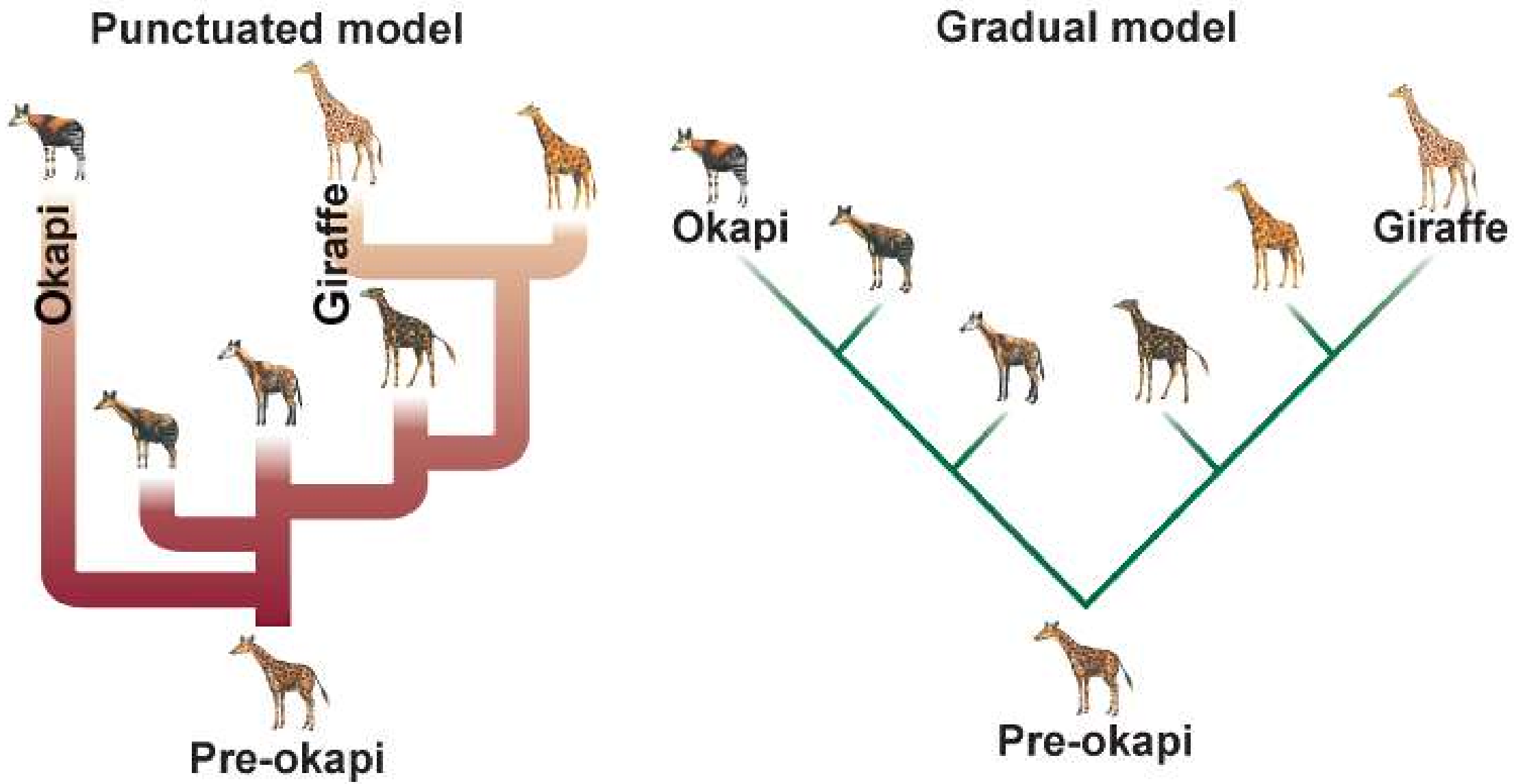
Condition	Violation	Consequence
The population is very large.	Many populations are small.	Chance events can lead to changes in population traits.
There is no immigration or emigration.	Organisms move in and out of the population.	The population can lose or gain traits with movement of organisms.
Mating is random.	Mating is not random.	New traits do not pass as quickly to the rest of the population.
Mutations do not occur.	Mutations occur.	New variations appear in the population with each new generation.
Natural selection does not occur.	Natural selection occurs.	Traits in a population change from one generation to the next.

Biodiversity

- The variety of organisms, their genetic information, and the communities in which they live.
- Ecosystem diversity
  - Includes the variety of habitats, living communities, and ecological processes in the living world.
- Species diversity
  - Includes the vast number of different organisms on Earth.
- Genetic diversity
  - refers to the sum total of all the different forms of genetic information carried by all living organisms on Earth.
  - Gives rise to inheritable variation, which scientists believe provides the raw material for evolution.

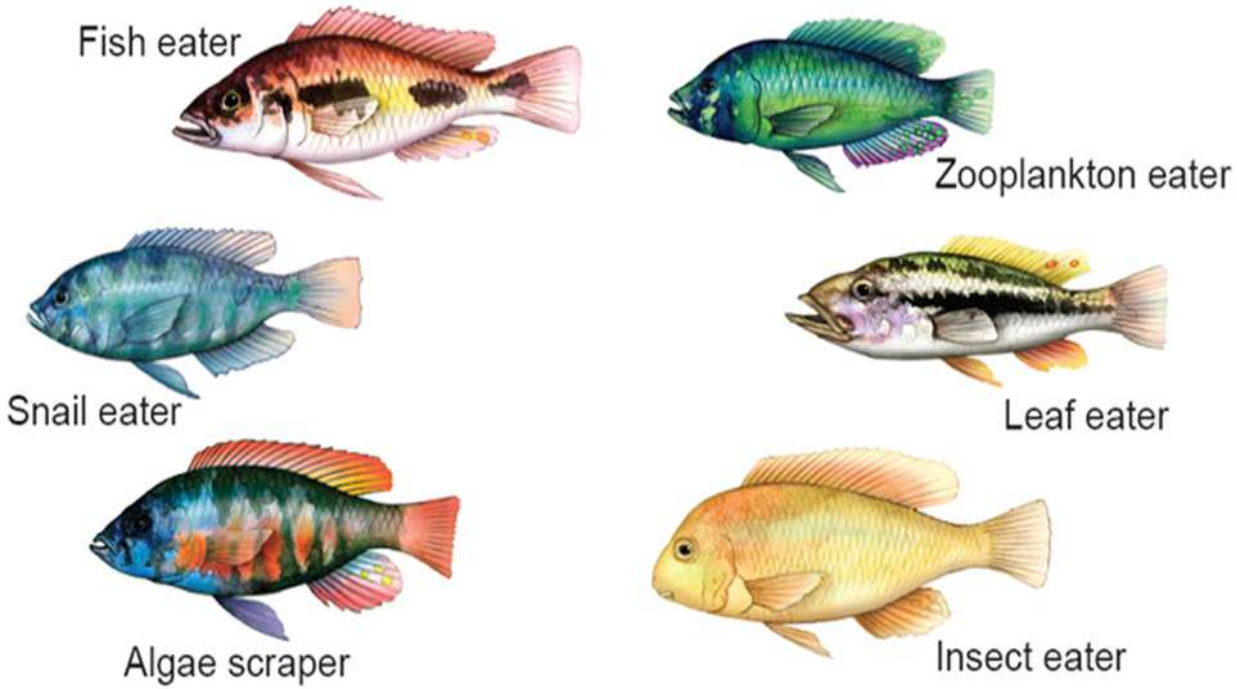
Speciation

- The evolution of new species
  - Can occur when species interbreed or when the production of fertile offspring is prevented
  - Behavioral isolation – two populations have differences in courtship rituals or other types of behavior
  - Geographic isolation – two groups become separated and no longer interbreed
    - Eventually each group evolves to their new environment and become so different that new species have formed
  - Temporal isolation –two or more populations reproduce at different times
- Gradualism – evolution occurs over a long period of time; slow and steady
- Punctuated equilibrium – evolution occurs quickly in rapid bursts with long periods of stability in between


Punctuated model
Okapi
Giraffe
Pre-okapi
Gradual model
Okapi
Giraffe
Pre-okapi

Adaptive Radiation

- When several different species evolve from a single species in response to the creation of new habitat or some other ecological opportunity.
- Follows a large scale extinction event.
- Ex: Darwin's Finches



Evolution

- **Divergent evolution** - When closely related species evolve in different directions.
  - May have different appearances that result from adapting to different environments
  - Wolf vs Tasmanian wolf
- **Convergent evolution** – unrelated species independently evolve similarities because they live in similar environments
  - Ex. Fins of dolphins and sharks
- DNA provides the best evidence for evolutionary relationships
  - Humans and chimps are 99% identical at the DNA level

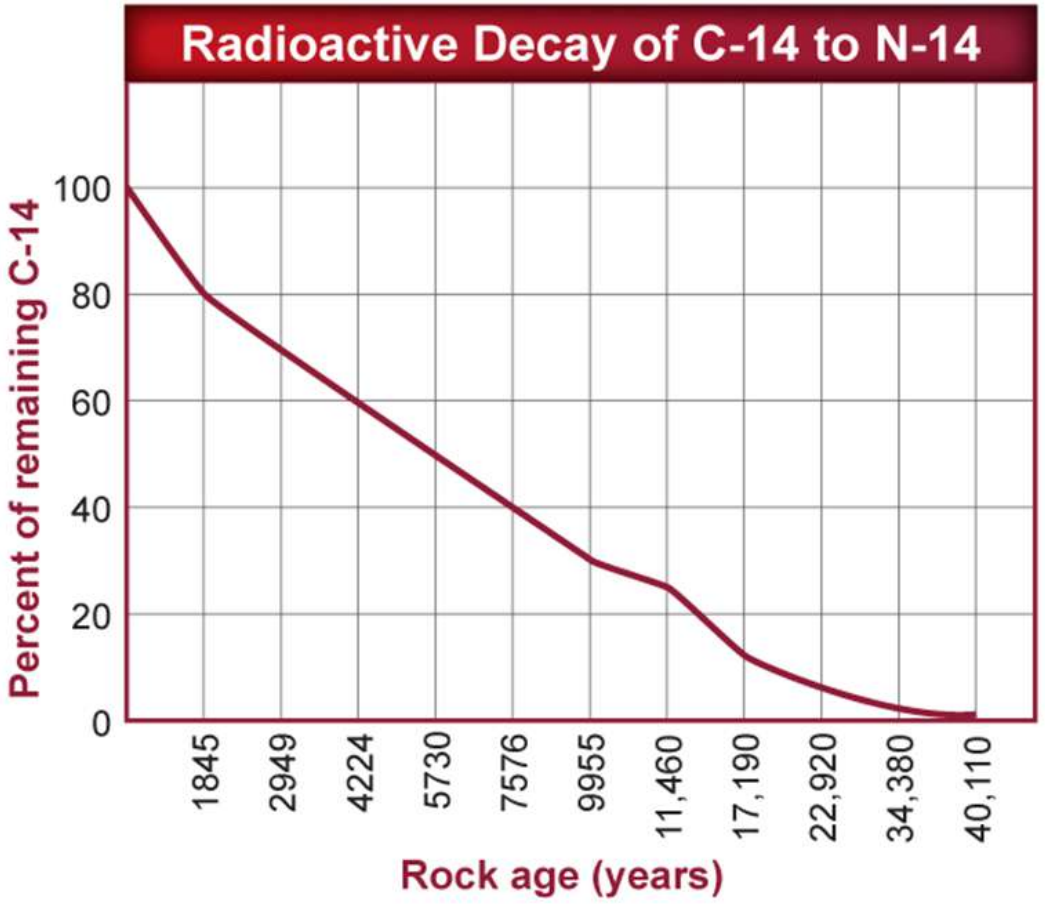
Convergent Evolution

Niche	Placental Mammals	Australian Marsupials
Burrower	 Mole	 Marsupial mole
Anteater	 Lesser anteater	 Numbat (anteater)
Mouse	 Mouse	 Marsupial mouse
Glider	 Flying squirrel	 Flying phalanger
Wolf	 Wolf	 Tasmanian wolf

Fossils

Radiometric Dating

- Age determined by comparing relative percentages of a radioactive isotope and a stable isotope
  - Radioactive isotope = parent
  - Stable isotope = daughter
- Using known decay rate, can calculate absolute age
- Half-life: the amount of time it takes for half of the isotope in a sample to decay to a different element.
  - Not affected by environmental conditions.



Radioactive Isotopes

- Uranium-238 or 238U
  - An isotope of uranium
  - Extremely long half-life, 4.5 billion years
  - Most useful for dating geologic samples that are more than 10 million years old.

- Potassium-40 or 40K
  - Has a half-life of 1.25 billion years
  - Used to date rocks that are between 50,000 and 4.6 billion years old.

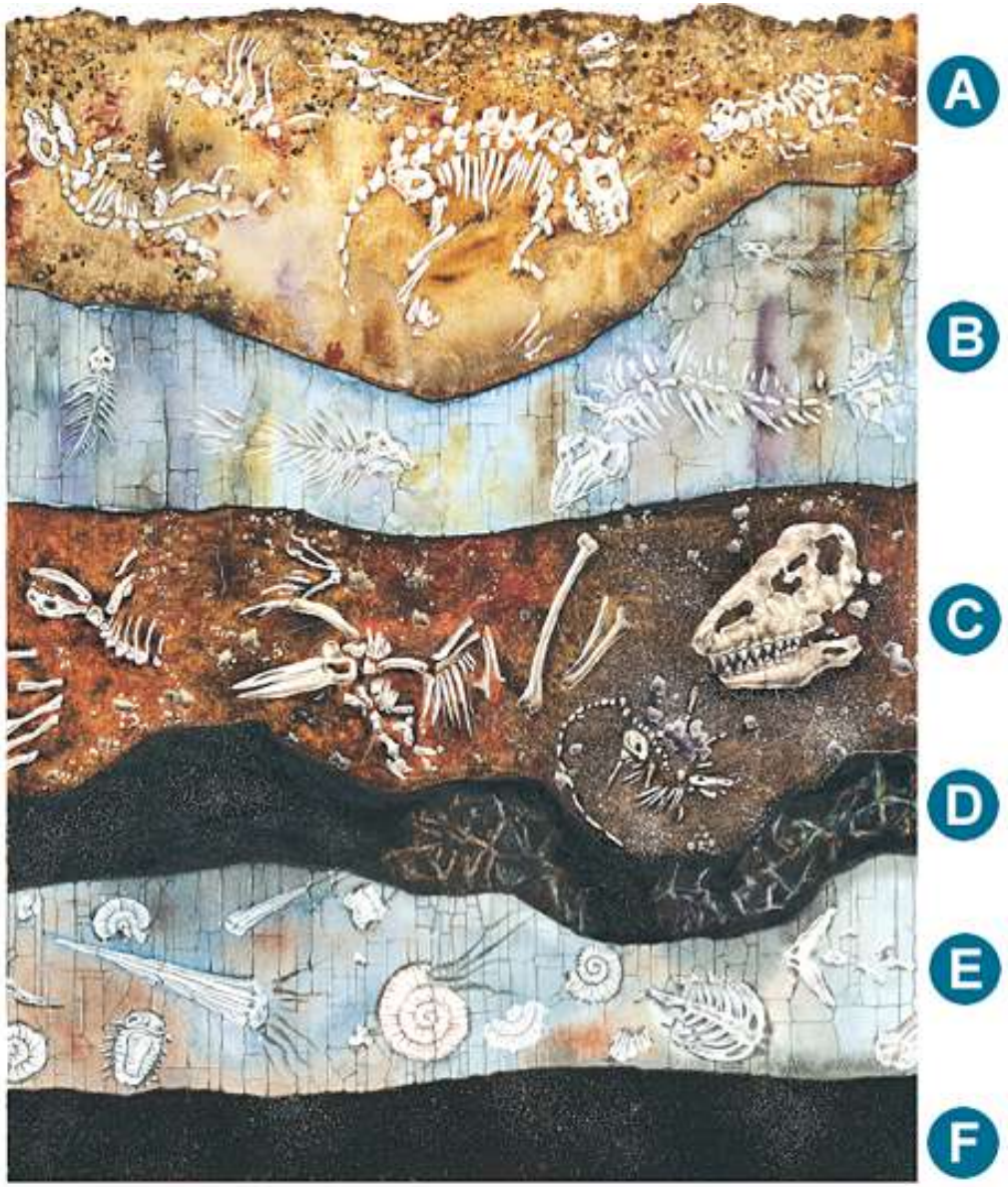
- Rubidium-87 or 87Rb
  - Has a half-life of about 49 billion years
  - Used to verify the age of rocks previously dated by using 40K.

Carbon Dating

- All living organisms have both the carbon-12 and carbon-14 isotope.
- To find the age of a sample of organic material, scientists compare the ratio of 14C to 12C and then compare this with the ratio of 14C to 12C known to exist in a living organism.

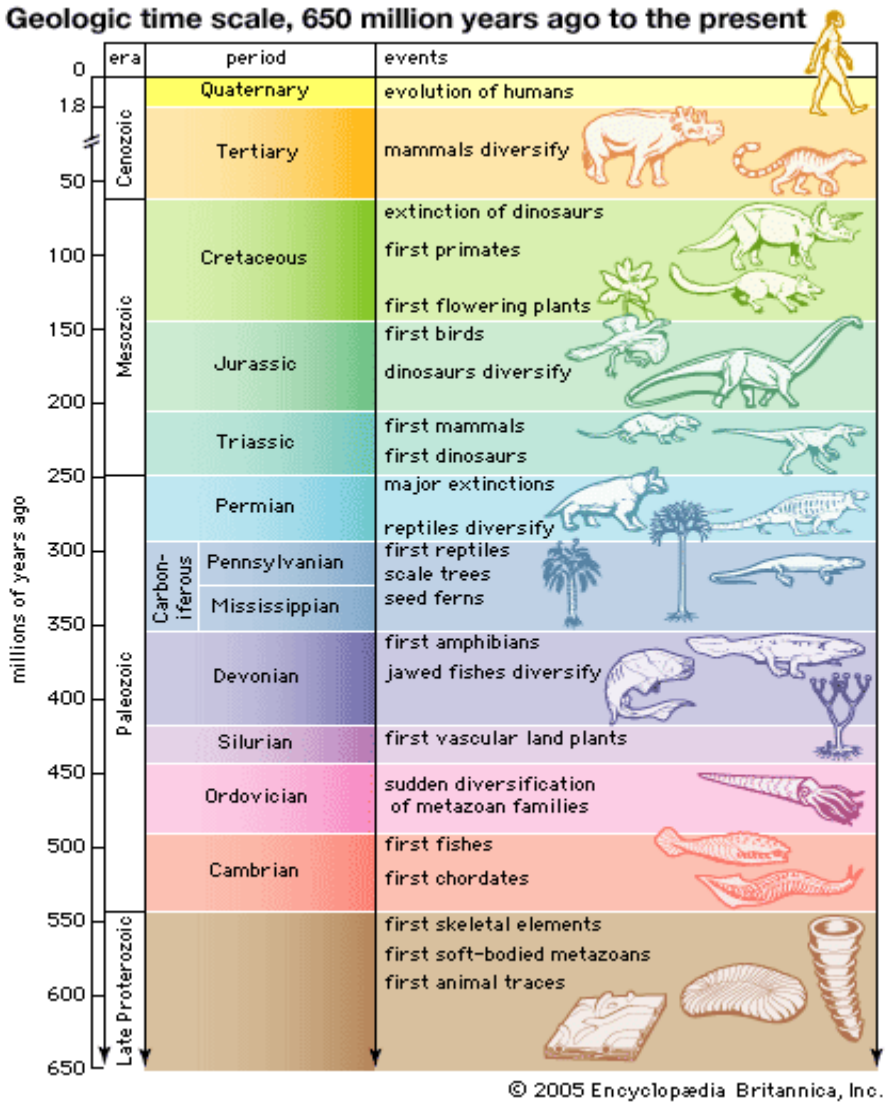
Relative Age

- Indicates that one layer of rock is older or younger than another layer- does not indicate the rocks age
- Layers of rock called strata, show the sequence of events that took place in the past



The Fossil Record

- Fossils: the trace or remains of an organism that lived long ago, most commonly preserved in sedimentary rock
- Fossils can also form without being buried if the organism becomes frozen or stuck in amber or tar



Types of Fossils

- Trace fossil
  - A fossilized mark that formed in sedimentary rock by the movement of an animal on or within soft sediment and provides clues about animal
- Imprints
  - Carbonized imprints of leaves, stems, flowers, and fish made in soft mud or clay have been found preserved in sedimentary rock.
- Molds and Casts
  - Molds are formed when the remains of an animal or plant is buried under layers of sediments which is later dissolved by underground water.
  - If the hollow spaces are filled with mineral material, it will form a cast fossil.
- Coprolites
  - Fossilized waste materials from ancient animals
  - Reveals the deeding habits of ancient animals, such as dinosaurs

Types of Fossils

- Gastroliths
  - Stones in dinosaur digestive systems to help them grind their food
  - Often recognized for their smooth, polished surface and proximity to dinosaur remains
- Index Fossils
  - A fossil that is used to establish the age of rock layers
    - Must be widespread
    - It must be distinct
    - Existed for only a short span of geologic time
    - Must be abundant

http://skywalker.cochise.edu/wellerr/fossil/gastrolith/gastrolithL.htm

Categories of Fossil Types

Category	Trace fossil	Molds and casts	Replacement	Petrified or permineralized	Amber	Original material
Example						
Formation	A trace fossil is any indirect evidence left by an organism. Footprints, burrows, and fossilized feces are trace fossils.	A mold is an impression of an organism. A cast is a mold filled with sediment.	The original material of an organism is replaced with mineral crystals that can leave detailed replicas of hard or soft parts.	Empty pore spaces are filled in by minerals, such as in petrified wood.	Preserved tree sap traps an entire organism. The sap hardens into amber and preserves the trapped organism.	Mummification or freezing preserves original organisms.

History of Life

Earth's Age

- Many thought it was 6,000 years old
  - Earth determined to be 4.6 billion years
- Hutton reasoned that change was very slow
  - Reasoned millions of years were needed to create the complicated rock structures in Earth's crust
- Supported Darwin's Theory of Evolution

http://www.fresnostate.edu/csm/ees/

Precambrian Time

- Ended 542 million years ago
- Almost 90% of the Earth's history
- Simple anaerobic forms of life appeared. These were followed by photosynthetic forms which added oxygen to the air
- Aerobic forms of life, eukaryotes appeared
- Some organisms gave rise to multicellular forms which continued to increase in complexity
- Few fossils; life existed only in the sea
  - Stromatolites most common fossils (reef like deposits from blue-green algae)
  - Tectonic activity deformed or altered rocks
- Continental shield appear

Paleozoic Era “ancient life”
Lasted 251 million years

- Early in the Paleozoic Era, the fossil record became rich with evidence of many types of marine life (jawless fish, trilobites, arthropods)
- Six periods:
  - Cambrian: 1st vertebrates appear 
  - Ordovician: free oxygen appears – some species become extinct
  - Silurian: land plants and animals appear
  - Devonian: amphibians, fish and cone bearing trees appear
  - Carboniferous: forest and swamps cover land, coal and reptiles appear, mountain formation
  - Permian: Pangaea forms, mass extinction

Mesozoic Era “Age of Reptiles” Lasted 65.5 million years

- Events during the Mesozoic Era include the increasing dominance of dinosaurs. The Mesozoic Era is marked by the appearance of flowering plants.
- Three periods:
  - Triassic: dinosaurs and mammals appear, conifer and cycads appear
  - Jurassic: primitive birds and flying reptiles appear
  - Cretaceous: flowering plants and modern birds appear, mass extinction

Cenozoic Era “Age of Mammals”

- During the Cenozoic Era, mammals evolved adaptations that allowed them to live in various environments- on land, in water and even in the air
- Two periods:
  - Tertiary: 1st primates appear, various mammals appear (dogs, horses, whales, pigs, squirrels, etc.)
  - Quaternary: humans appear, the Earth cooled causing a series of ice ages, Pangaea breaks apart

Question #1

Ancestors of the koala lived on the ground, but modern koalas live in trees and eat eucalyptus leaves, which are poisonous to most other animals. The difference between the ancestor and modern koalas was caused by

a. the presence of homologous structures
b. the presence of vestigial organs
c. selective breeding
d. natural selection

Question #2

Horses and tapirs have a common ancestor, but now look very different. Horses now are grassland animals adapted for grazing on grass and shrubs. Tapirs are jungle animals that live in dense forests and eat fruit, leaves, and aquatic vegetation. Which of the following led to the development of such differences in the two species?

a. selective breeding
b. convergent evolution
c. DNA hybridization
d. natural selection

Question #3

Fossils of Archeopteryx show that this animal had feathers, like a bird. It also had a bony tail, teeth, and claws on its wings, like a reptile. This fossil is evidence that supports the idea that

a. birds and reptiles have a common ancestor
b. birds have changed very little over 150 million years
c. reptile species are more advanced than bird species
d. reptiles are warm-blooded like birds

Question #4

Although the Arctic fox and the kit fox are closely related, they look very different because the individuals

a. acquired traits during their lifetimes that contributed to survival
b. with traits most suited to their environments reproduced most successfully
c. migrated long distances to environments that most suited their traits
d. passed on to their offspring acquired behaviors that were helpful

Question #5

Some viral diseases require only one vaccination, which lasts for years. For other diseases like the flu, vaccinations last only one season. The flu vaccine lasts such a short time because the flu virus

a. is more easily transmitted
b. mutates much more rapidly
c. is less dangerous
d. is much smaller

Question #6

From the following answers, which is considered by most biologists to be the most accurate in supporting the theory of evolution?

a. fossils
b. embryology
c. DNA sequencing
d. genetic equilibrium

Question #7

The development of radiocarbon dating allows scientists to see how many times carbon atoms have been through half-lives. Since scientists know the length of a C-14 half-life, they can gain knowledge about fossils using the C-14 dating technique. When radiocarbon dating was first introduced, it changed the way people thought about how organisms evolved because the technique showed

a. how long ago some organisms were alive
b. that eating habits have changed in some animals
c. how different the chemical composition was long ago
d. that most plants were gymnosperms

Question #8

There are millions of species of organisms living at this time and new species are still being discovered. Based on Darwin's theory of evolution, which of the following best describes how millions of species have developed?

a. Organisms passed on acquired characteristics to evolve from lower life forms to higher life forms.
b. Organisms were selectively bred to create different species.
c. Completely different species crossed with one another to form the many different organisms.
d. Different genetic variations in organisms were selected in different environments.

Question #9

Which of the following best supports the idea that organisms and environments have changed over time?

a. The discovery of fossilized fern plants in Antarctica
b. The production of sterile hybrid animals such as the mule
c. The many different species of plants in tropical areas
d. The ability of many animals to learn new behaviors

Question #10

The cotton whitefly has become a key pest, damaging many kinds of crops. The cotton whitefly has developed resistance to a variety of pesticides. Pesticide resistance would most likely develop in insects that

a. reproduce rapidly
b. feed on few types of plants
c. undergo complete metamorphosis
d. live in very limited regions

Question #11

The DNA of an organism contains information that is used to sequence amino acids to form specific proteins. The existence of different organisms with very similar amino acid sequences is evidence of

a. a common ancestor
b. common adaptive behaviors
c. a similar diet
d. a similar environment

Question #12

Microorganisms such as bacteria are able to change and adapt much more quickly than other organisms. Bacterial populations, for example, are able to build a resistance to antibiotics within months, whereas compounds that are toxic to animals remain toxic to animals for many years. One reason for their rapid adaptability is that microorganisms

a. are highly motile
b. have a short life span
c. have specialized organelles
d. are chemosynthetic

Question #13

Which evolutionary pattern is represented by the similarities between these two organisms that live on separate continents?

a. coevolution
b. convergent evolution
c. directional evolution
d. divergent evolution

Question #14

Which explains why the tortoises on the different islands of the Galápagos had slightly different variations in their shells?

a. The different tortoises were different species.

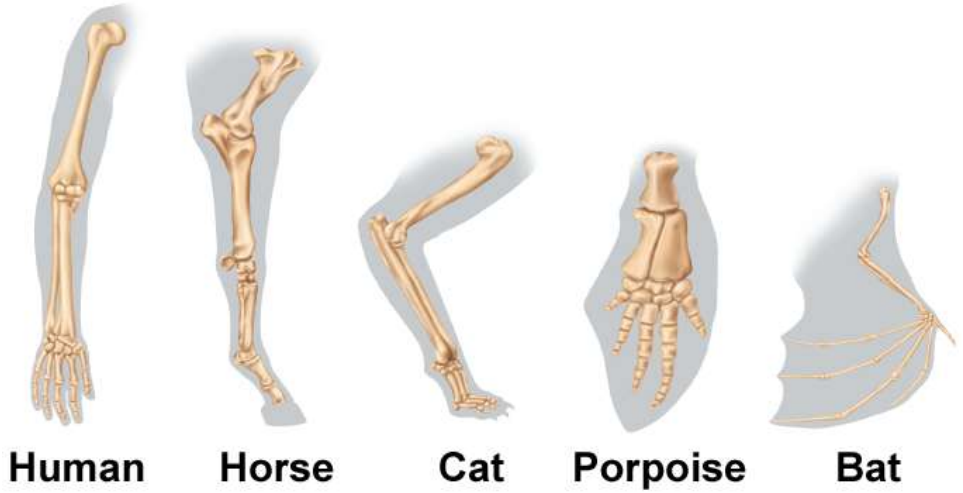
b. The environment on each island was different.

c. Each type of tortoise could survive only on its own island.

d. They arrived on the islands from different continents.

Question #15

Which is the best explanation for the similarities in the construction of these forelimbs?



a. Each forelimb is a similar modification derived from a different ancestor.
b. Natural selection has produced similar modifications in the forelimb.
c. They are functionally similar features that have evolved independently.
d. They are modifications of the forelimbs of a common ancestor.

Question #16

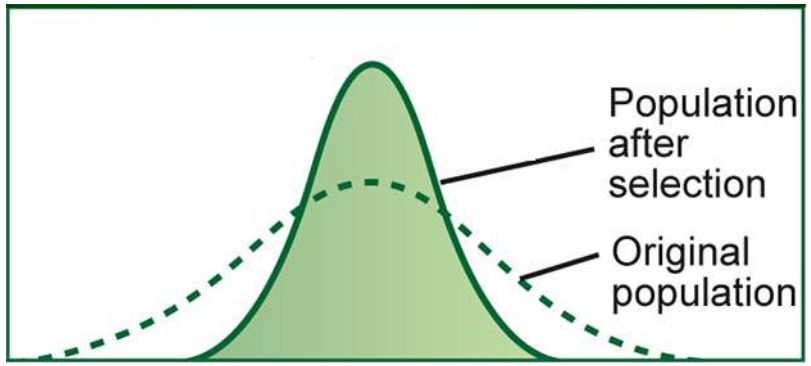
Predators learn to avoid monarch butterflies because they contain a poison that is distasteful and can cause the predator to get sick. The viceroy butterfly finds protection by closely resembling the monarch. What is this adaptation in the viceroy called?

a. camouflage
b. fitness
c. mimicry
d. resemblance

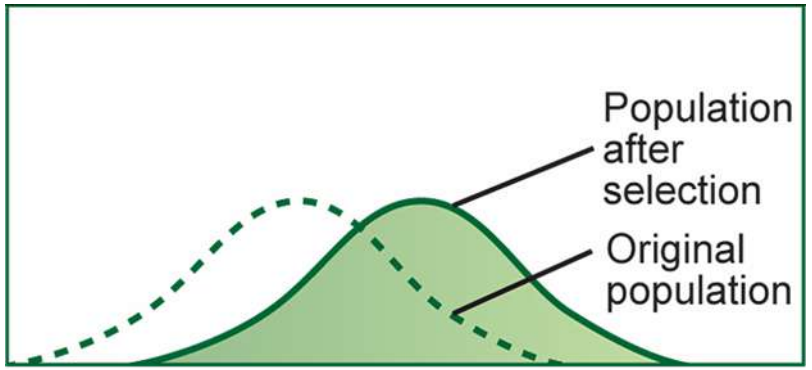
Question #17

Within a population of squirrels, those that live higher in the mountains where it is cooler have long fur. Squirrels that live in the foothills where it is warmer have short fur. The original population is believed to have had intermediate fur length. Which graph represents this type of natural selection?

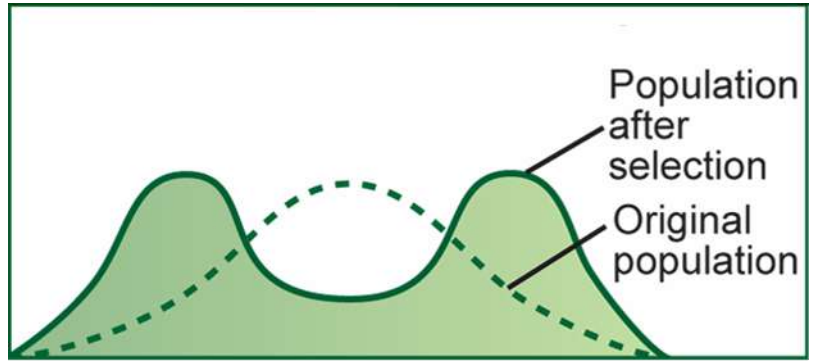
A.



B.

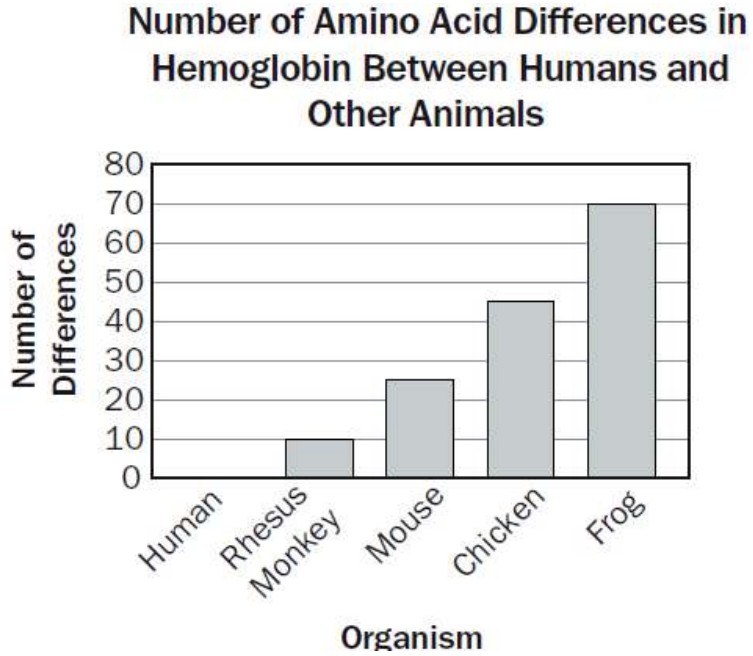


C.



Question #18

The graph shows the number of differences in the amino acids of a particular hemoglobin polypeptide in different organisms.

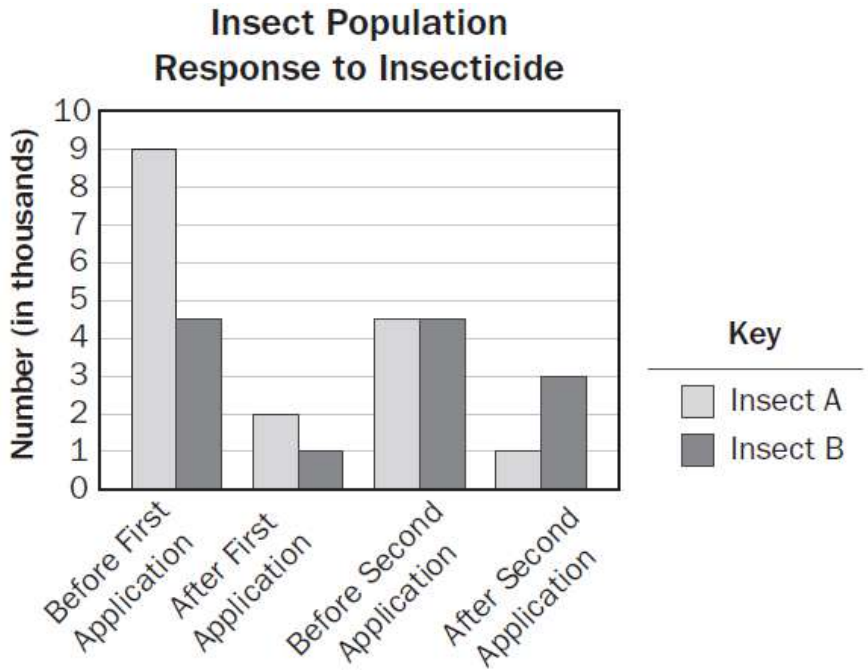


What inference can be made from the data in the graph?

a. Rhesus monkeys and mice do not share a common ancestor.
b. Hemoglobin is more important to frogs than to other organisms.
c. Humans and rhesus monkeys are more similar than chickens and frogs.
d. Amino acids are the building blocks of hemoglobin in all organisms except humans.

Question #19

Scientists and farmers studied how populations of insects on a farm changed after the farmer started using an insecticide on the crops. The diagram shows population sizes, both before and after the insecticide was applied.



What conclusion can be made about the Insect A and Insect B populations?

a. The insecticide was specific to Insect B.
b. The insecticide became less effective for Insect A.
c. Some insects passed a beneficial mutation to offspring.
d. The farmer missed spraying insecticide on some plants.

Question #20

Scientists noted that each of several anole lizard species in the Caribbean islands has a body type that seems to be well suited for its own habitat. For example, the anole species that live mainly on tree trunks have stocky bodies and long legs. Anoles that live in grassy areas are slender and have very long legs. Scientists also noted that distinct anole species with the same body types can be found on several different islands. These findings are consistent with the mechanism of natural selection, which favors adaptations that allow a species to survive in its environment.

The scientists developed a few hypotheses for the finding that the twig-dwelling anole species found on several of the islands have thin bodies, large toe pads, and short legs and tails. They then performed DNA analysis on each of these twig-dwelling species. This analysis revealed that the twig-dwelling species on different islands did not share a recent common ancestor.

Which of these hypotheses is supported by the findings?

a. A species of twig-dwelling anoles developed on one island, and then descendants spread out to other islands.
b. The twig-dwelling anoles are much better adapted to living in the Caribbean islands than the trunk-dwelling and grass-dwelling anoles.
c. Each twig-dwelling species came from distant ancestors but evolved in similar ways despite separated habitats.
d. Twig-dwelling anoles, trunk-dwelling anoles, and grass-dwelling anoles all evolved from the same ancestor.

Information and images obtained from:

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