

A silhouette of a tree with a large, rounded canopy stands on a rocky outcrop. The background is a vibrant sunset or sunrise, with a gradient from deep blue at the top to bright orange and yellow at the horizon. The text is overlaid on the left side of the image.

Biology

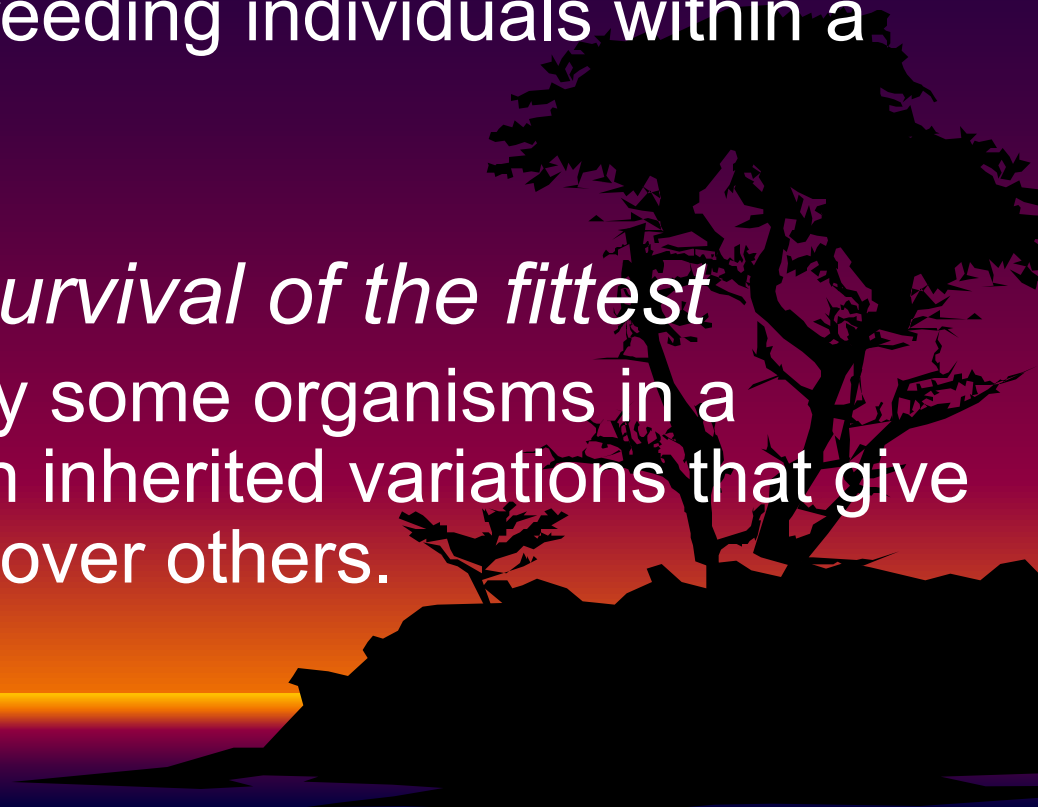
Unit 3: Evolution

Ch. 10: Principles of Evolution

Ch. 11: Evolution of Populations

Ch. 12: History of Life

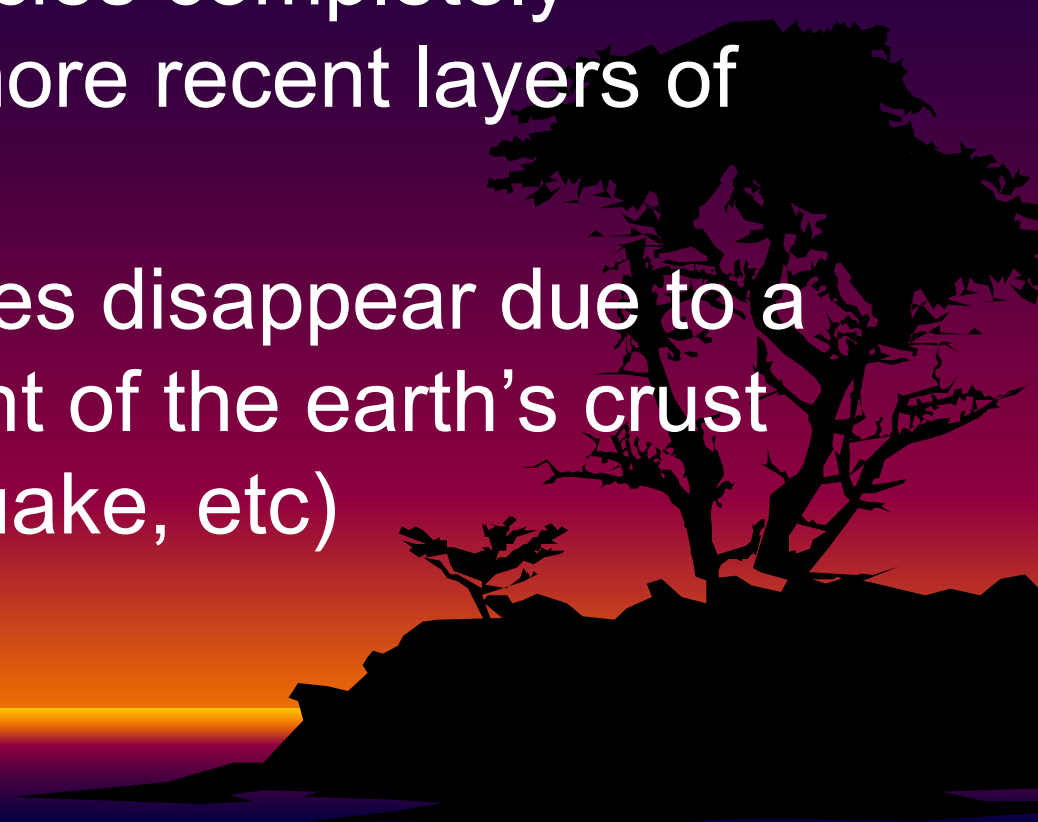
Basic Definitions

- Evolution: *the process of change over time*
 - evolution is a change in the genetic makeup of a population of interbreeding individuals within a species.
 - Natural Selection: *survival of the fittest*
 - the process whereby some organisms in a species have certain inherited variations that give them an advantage over others.
- 
- A silhouette of a tree is positioned on the right side of the slide, set against a background of a sunset or sunrise. The sky transitions from a deep purple at the top to a bright orange and yellow near the horizon, with a dark blue area at the bottom. The tree's branches are dark and detailed, extending towards the right edge of the frame.

Early Geologic Ideas About Evolution

CATASTROPHISM

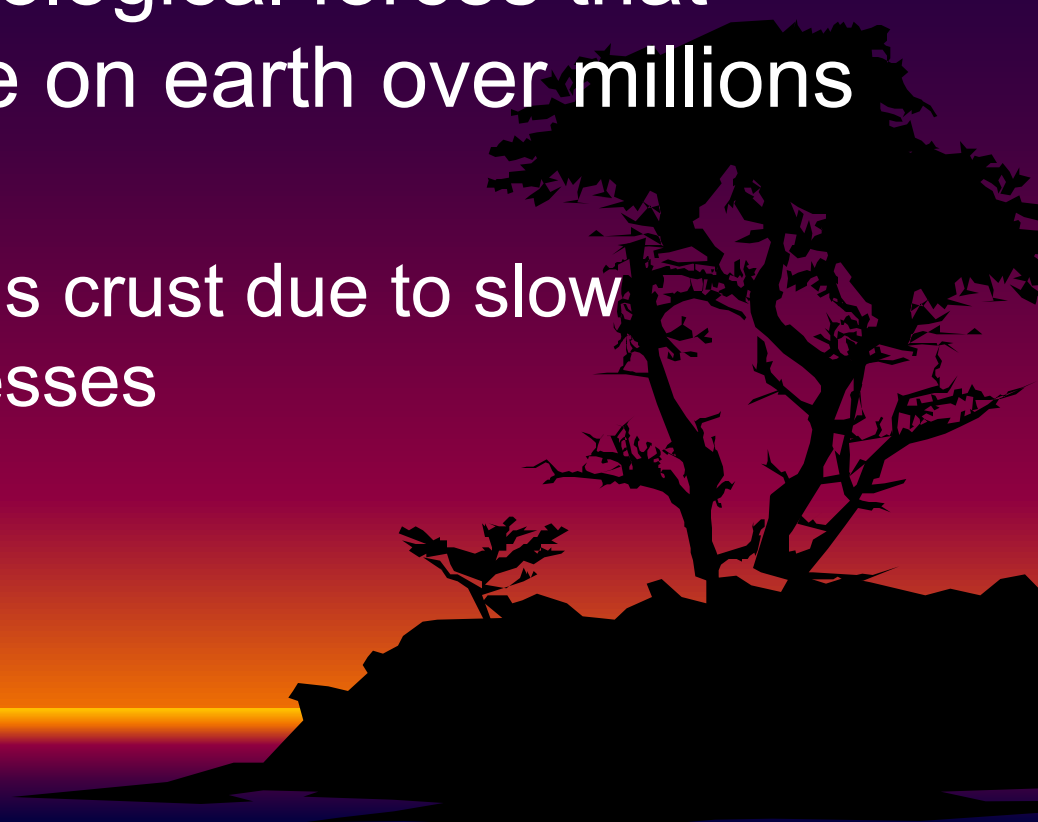
- Idea proposed by George Cuvier
- Found some species completely disappeared in more recent layers of rock
- Stated that species disappear due to a catastrophic event of the earth's crust (volcano, earthquake, etc)



Early Geologic Ideas About Evolution

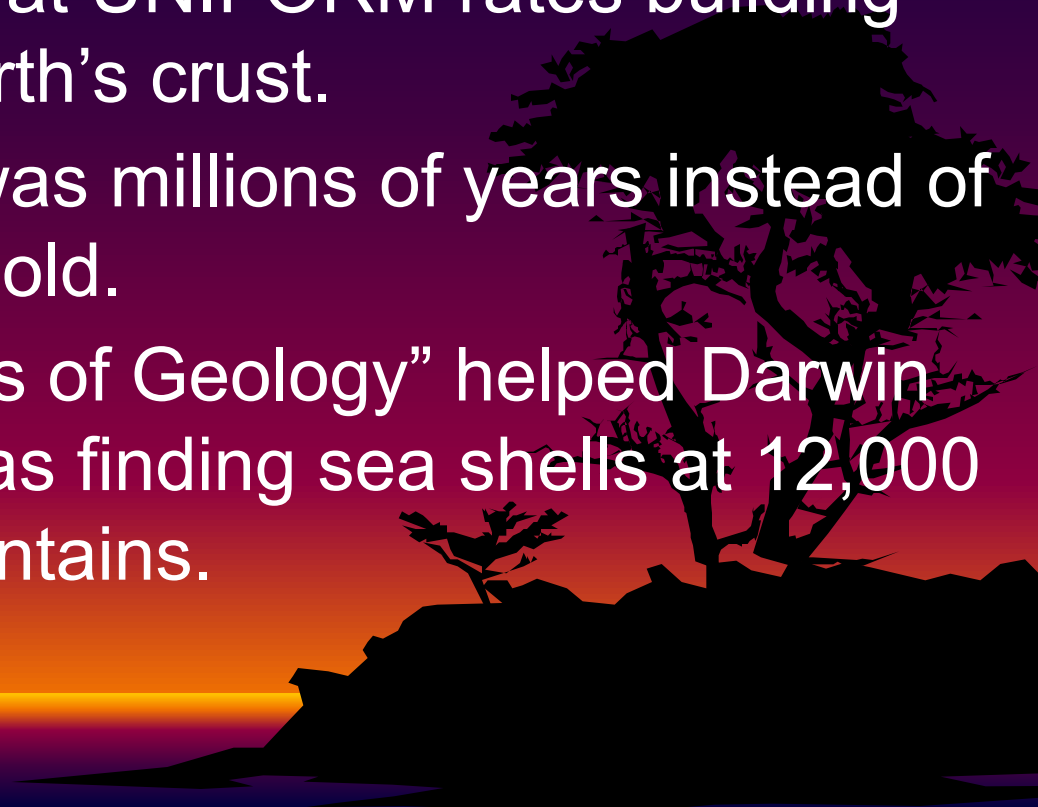
GRADUALISM

- 1795- James Hutton- Geologist
- Described the geological forces that have changed life on earth over millions of years.
 - Changes in earths crust due to slow continuous processes

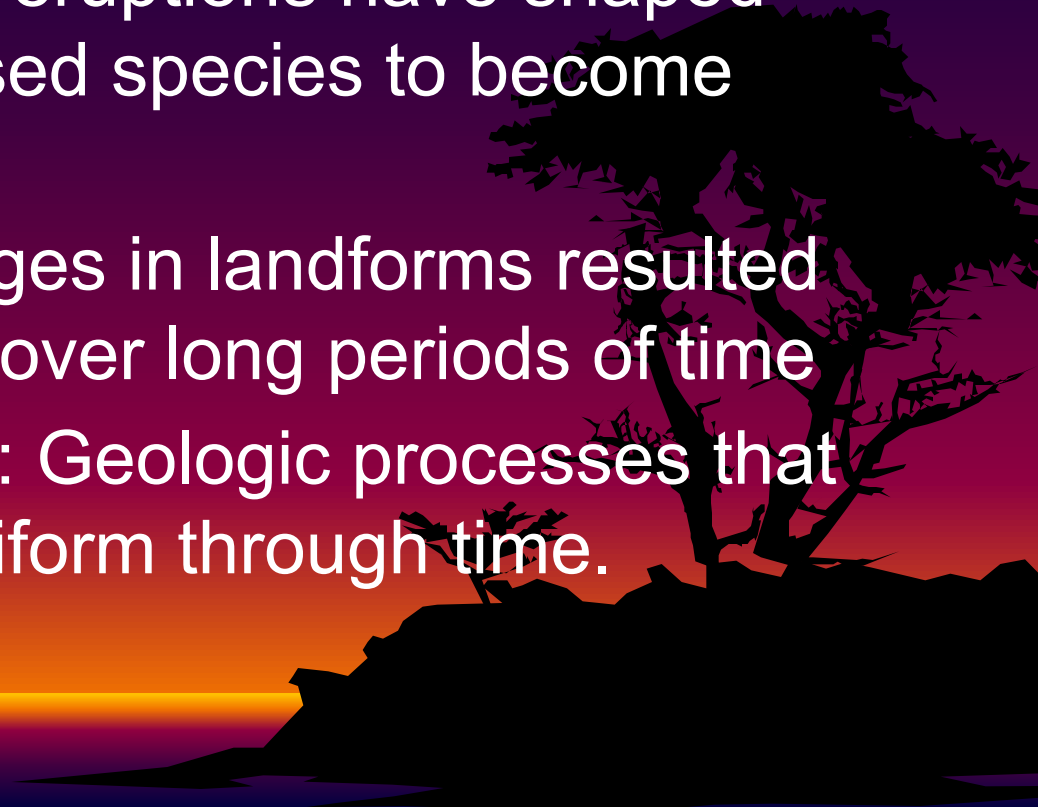


Early Geologic Ideas About Evolution

UNIFORMITARIANISM

- Proposed by Charles Lyell
 - Geological processes at UNIFORM rates building and wearing down Earth's crust.
 - Proposed that Earth was millions of years instead of a few thousand years old.
 - Lyell's book "Principles of Geology" helped Darwin understand why he was finding sea shells at 12,000 feet in the Andes mountains.
- 
- A silhouette of a large, leafy tree stands on a rocky outcrop. The background is a vibrant sunset or sunrise, with a gradient from deep blue at the top to bright orange and yellow at the horizon. The overall scene is dark and atmospheric.

Summary of Early Geologic Ideas About Evolution

- **Catastrophism**: Natural disasters such as floods and volcanic eruptions have shaped landforms and caused species to become extinct.
 - **Gradualism**: Changes in landforms resulted from slow changes over long periods of time
 - **Uniformitarianism**: Geologic processes that shape Earth are uniform through time.
- 
- A silhouette of a tree and a landscape against a sunset background. The sky transitions from a bright orange and yellow glow at the horizon to a deep purple and blue at the top. The tree is on the right side, and the landscape below it is dark and jagged, suggesting rocks or hills.

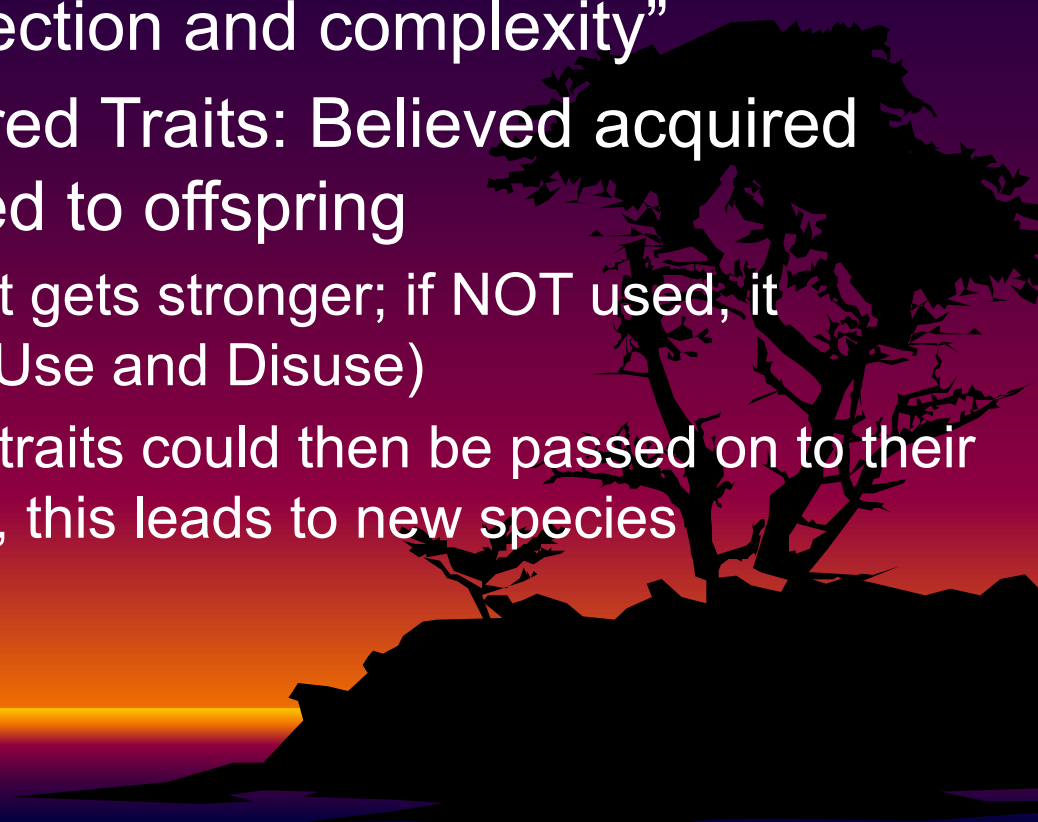
Early Biological Ideas About Evolution

JEAN-BAPTISTE LAMARCK

1809: Stated that changes are adaptations to the environment acquired in an organism's lifetime.

“Tendency toward perfection and complexity”

- Inheritance of Acquired Traits: Believed acquired changes were passed to offspring
 - If body part is used, it gets stronger; if NOT used, it deteriorates (Law of Use and Disuse)
 - These new/modified traits could then be passed on to their offspring...Over time, this leads to new species

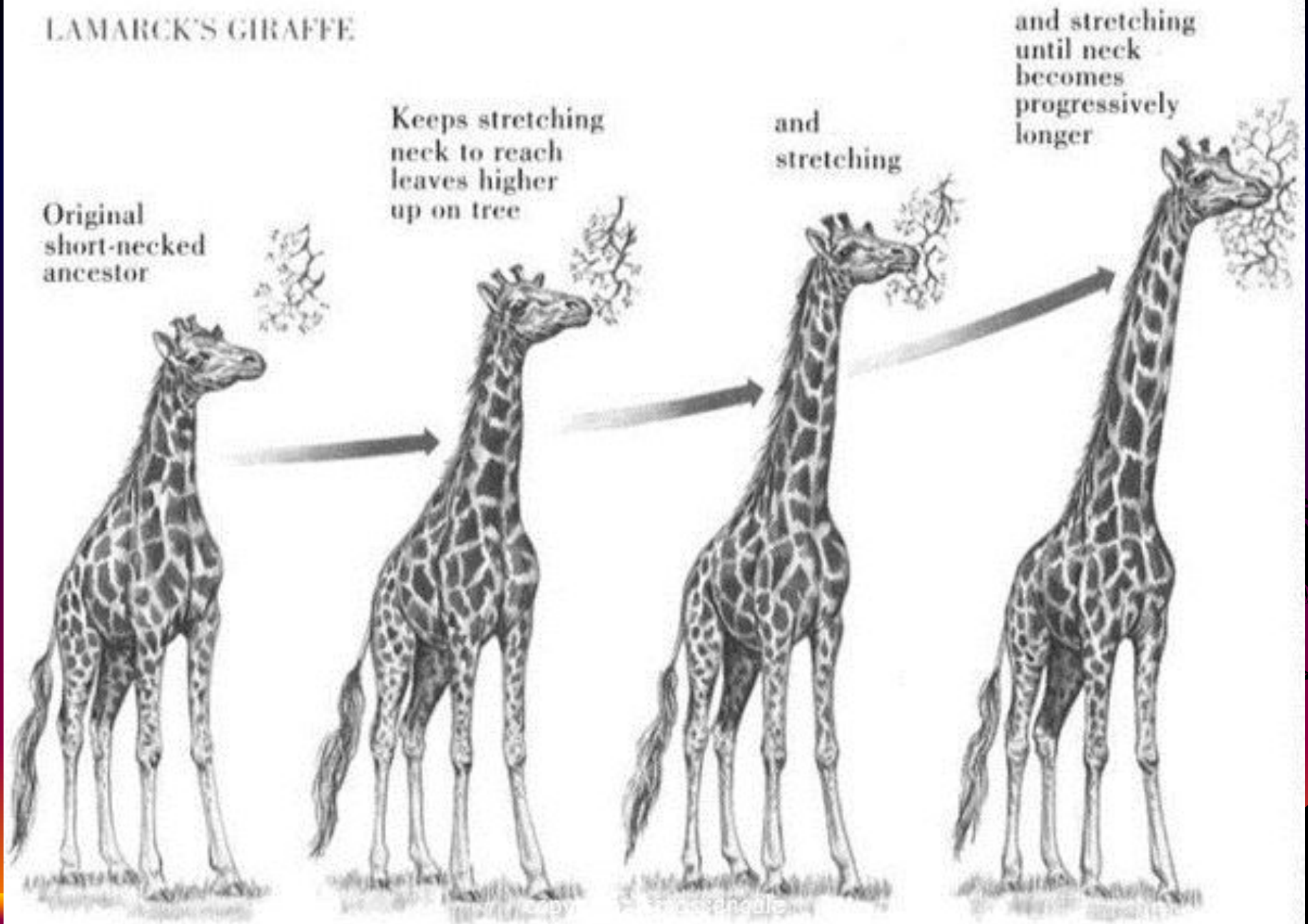


Lamarck's Theory of Evolution

- Examples:
 - Bird ancestors desired to fly, so they tried until wings developed
 - Giraffes' necks
 - Clipped ears of dogs could be passed to offspring



LAMARCK'S GIRAFFE



Original short-necked ancestor

Keeps stretching neck to reach leaves higher up on tree

and stretching

and stretching until neck becomes progressively longer

Driven by inner "need"

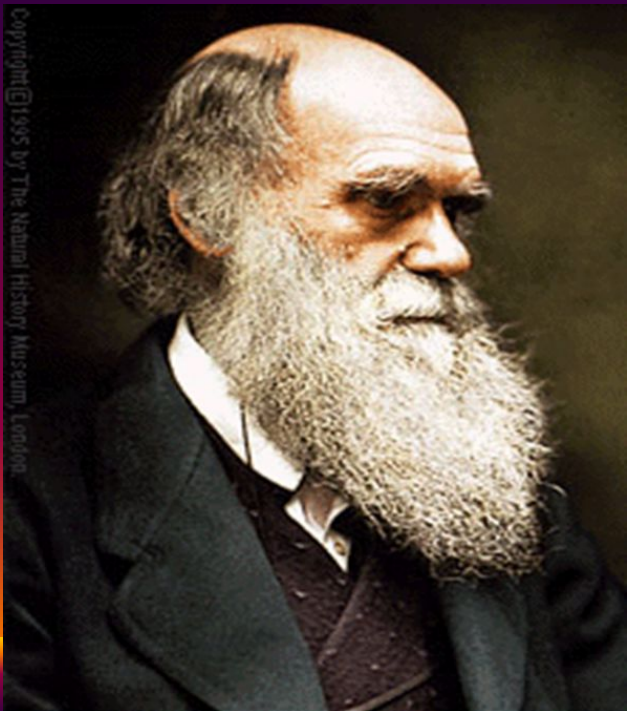
Issues with Lamarck's Theory

- Did not know how traits were passed through genes
- Genes are not changed by activities in life
- Change through mutation occurs before an organism is born

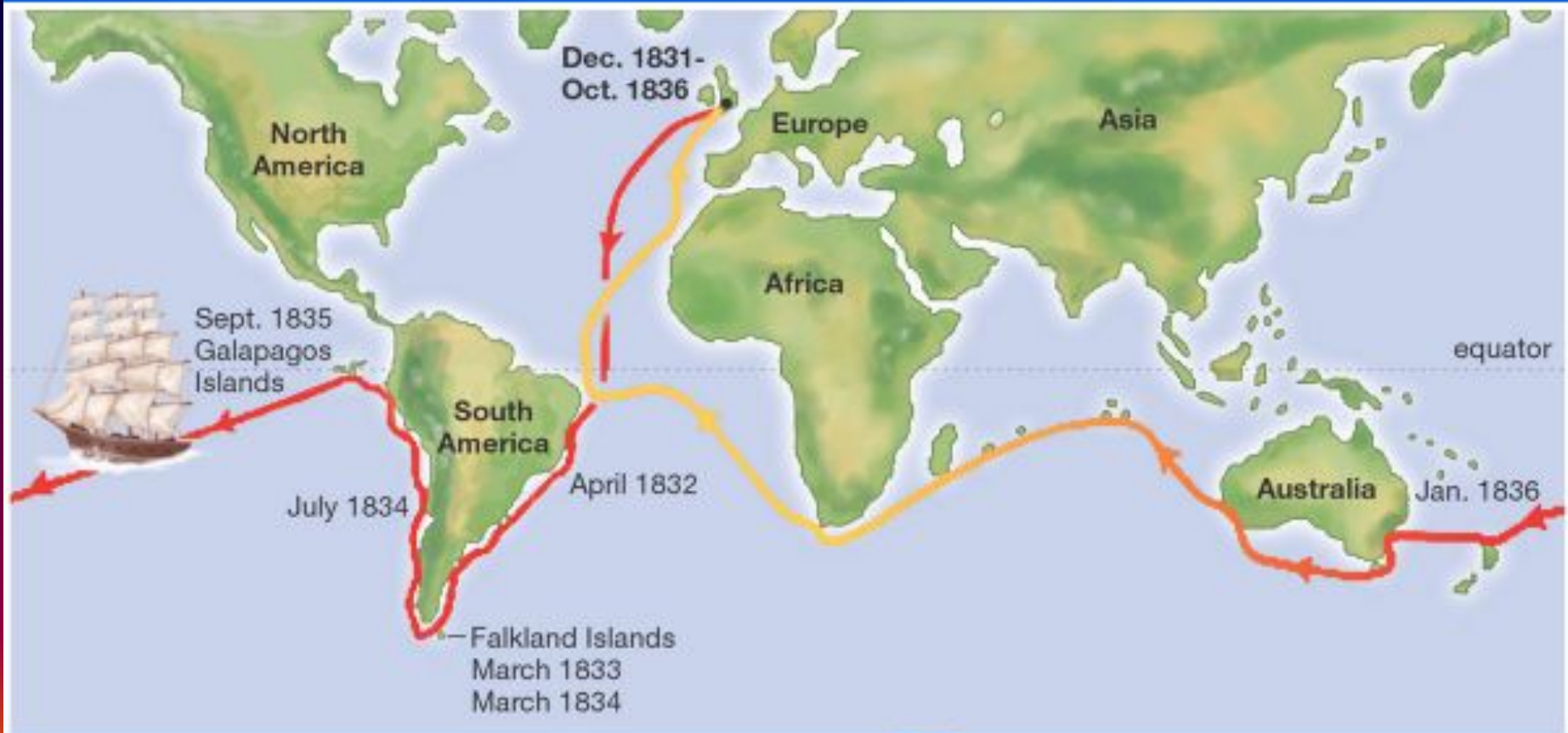


CHARLES DARWIN

Joined the crew of the HMS Beagle in 1831, for a 5 year voyage around the world



Darwin Left England in 1831

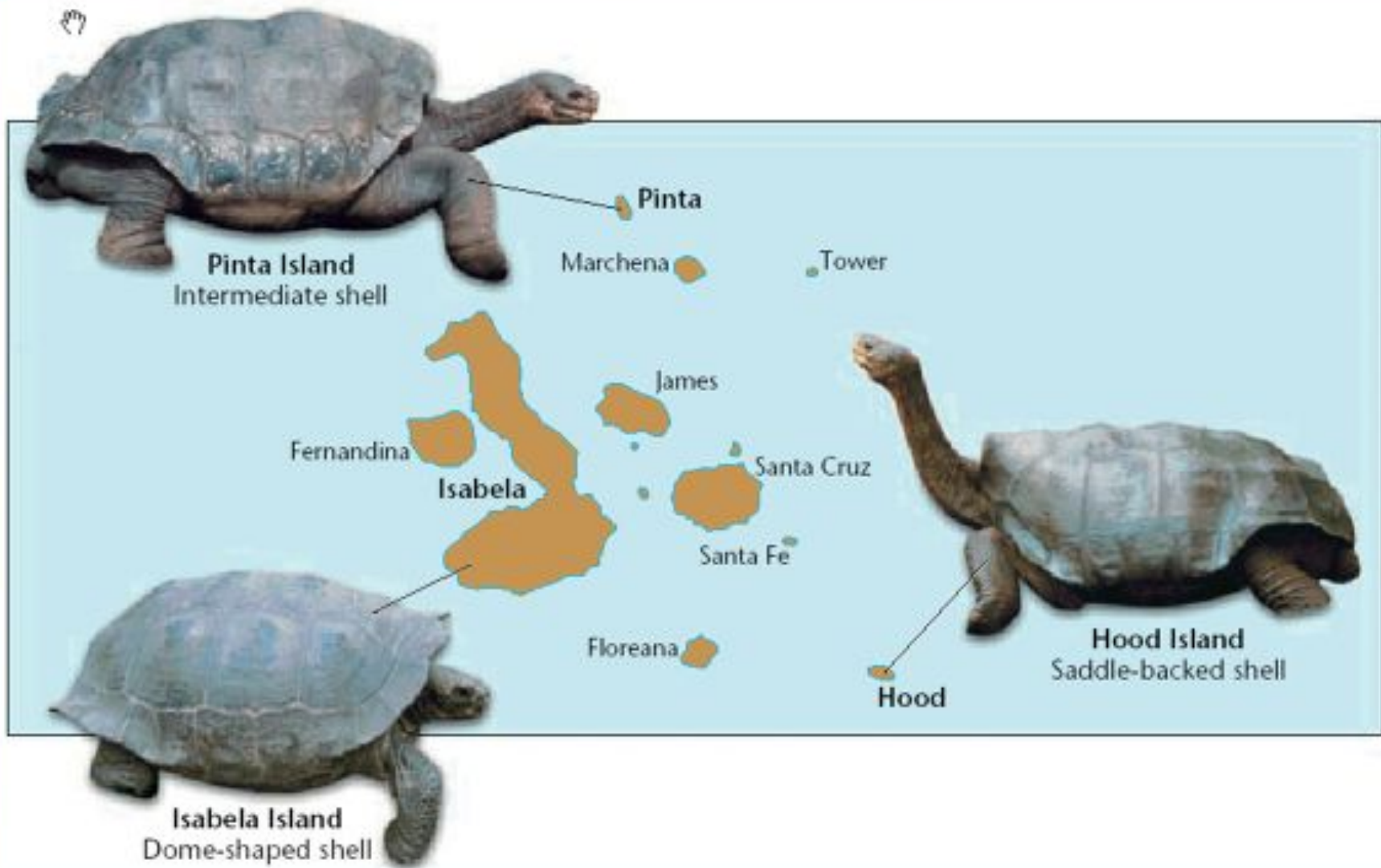


Darwin returned 5 years later in 1836

Darwin & the Galapagos Islands



- Small group of volcanic islands near Ecuador
- Unique wildlife (tortoises, iguanas, finches)
 - Island species varied from mainland species and from island to island species









© D.Cavagnaro/DRK Photo • © M.Cavagnaro/DRK Photo

Darwin & the Galapagos Islands

- Finches on the islands resembled mainland finches. More types of finches appeared on the islands where the available food was different
- Finches had different types of beaks adapted to their type of food gathering

Galápagos Islands Finches

Shape of Head and Beak						
Name	Vegetarian tree finch	Large insectivorous tree finch	Woodpecker finch	Cactus ground finch	Sharp-beaked ground finch	Large ground finch
Main Food	Fruit	Insects	Insects	Cactus	Seeds	Seeds
Feeding Adaptation	Parrotlike beak	Grasping beak	Uses cactus spines	Large crushing beak	Pointed crushing beak	Large crushing beak
Habitat	Trees	Trees	Trees	Ground	Ground	Ground











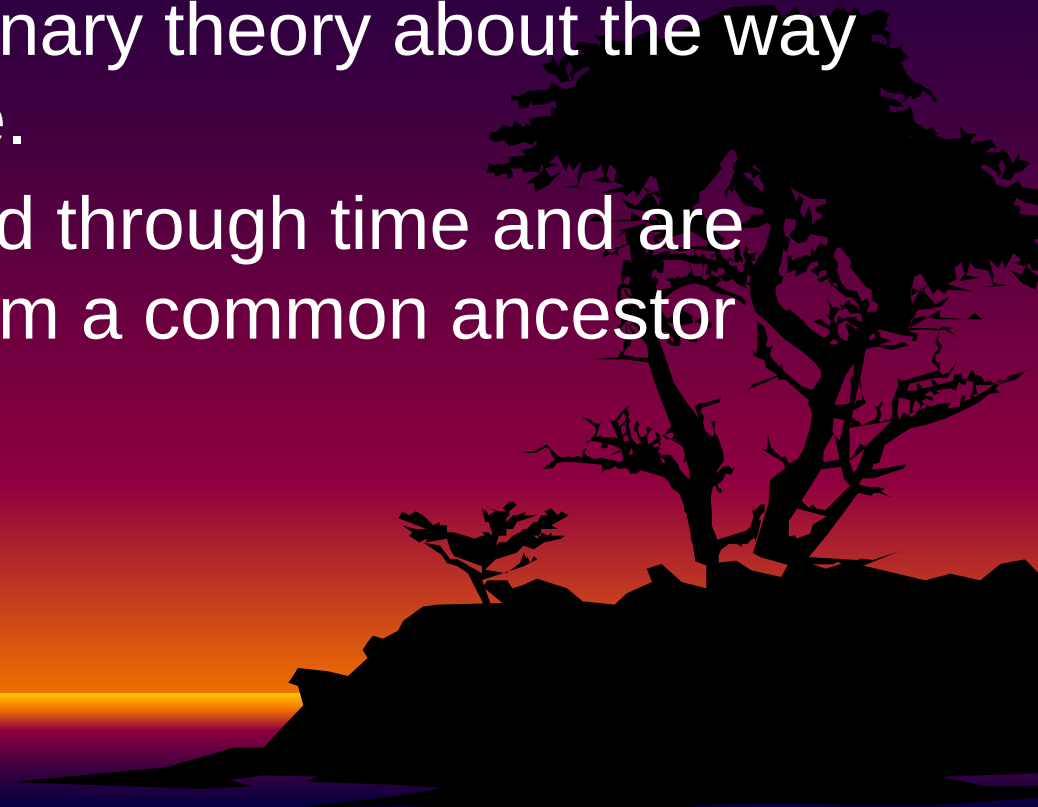






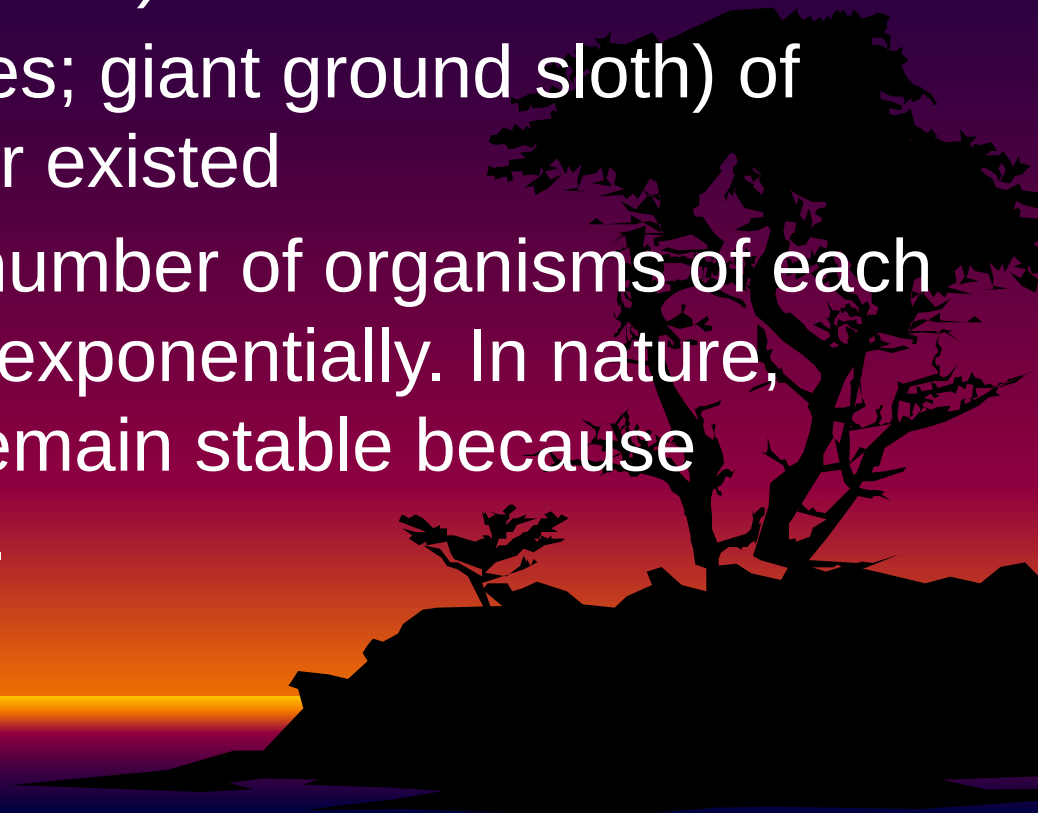
Darwin's Theory of Evolution by Natural Selection

- During his travels, Darwin made numerous observations and collected evidence that led him to propose a revolutionary theory about the way life changes over time.
- Species have changed through time and are related by descent from a common ancestor



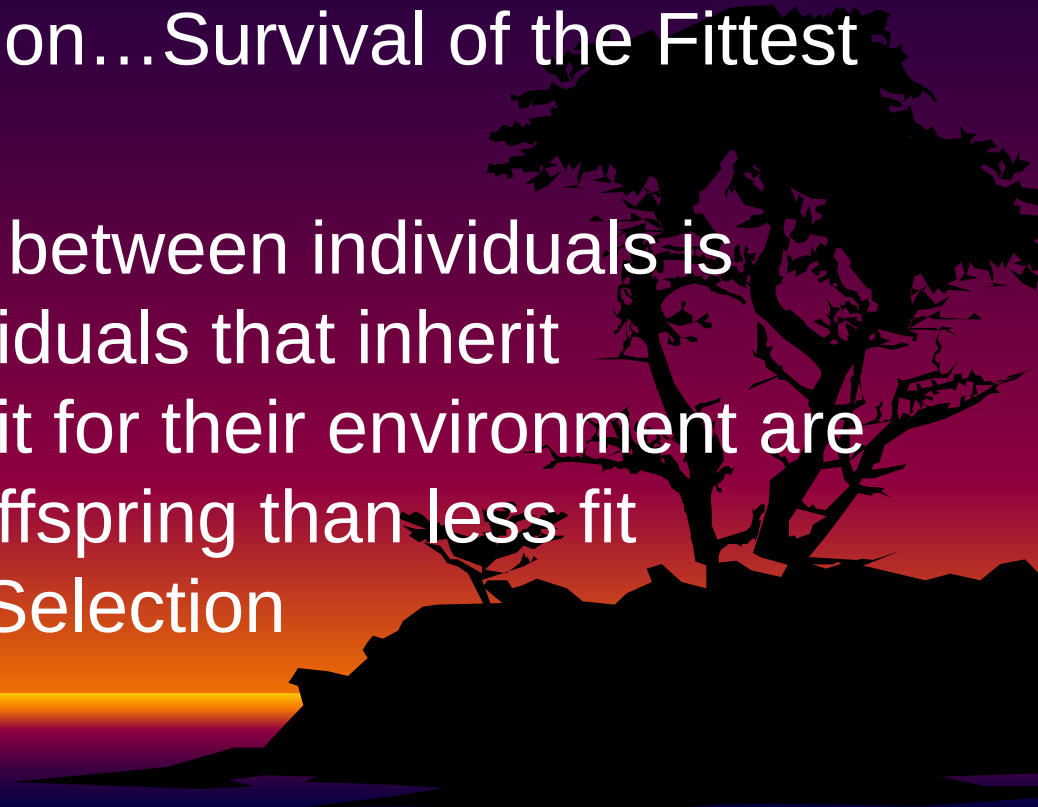
Darwin's Observations

- Unique adaptations in organisms
- Species not evenly distributed (Australia has kangaroos, but no rabbits)
- Found fossils (trilobites; giant ground sloth) of species that no longer existed
- Left unchecked, the number of organisms of each species will increase exponentially. In nature, populations tend to remain stable because resources are limited.



Darwin's Conclusions

- Production of more individuals than the environment can support leads to struggle for existence where only a fraction of offspring survive each generation...Survival of the Fittest
- Much of the variation between individuals is inheritable, thus individuals that inherit characteristics most fit for their environment are likely to leave more offspring than less fit individuals...Natural Selection



Darwin's Theory of Evolution

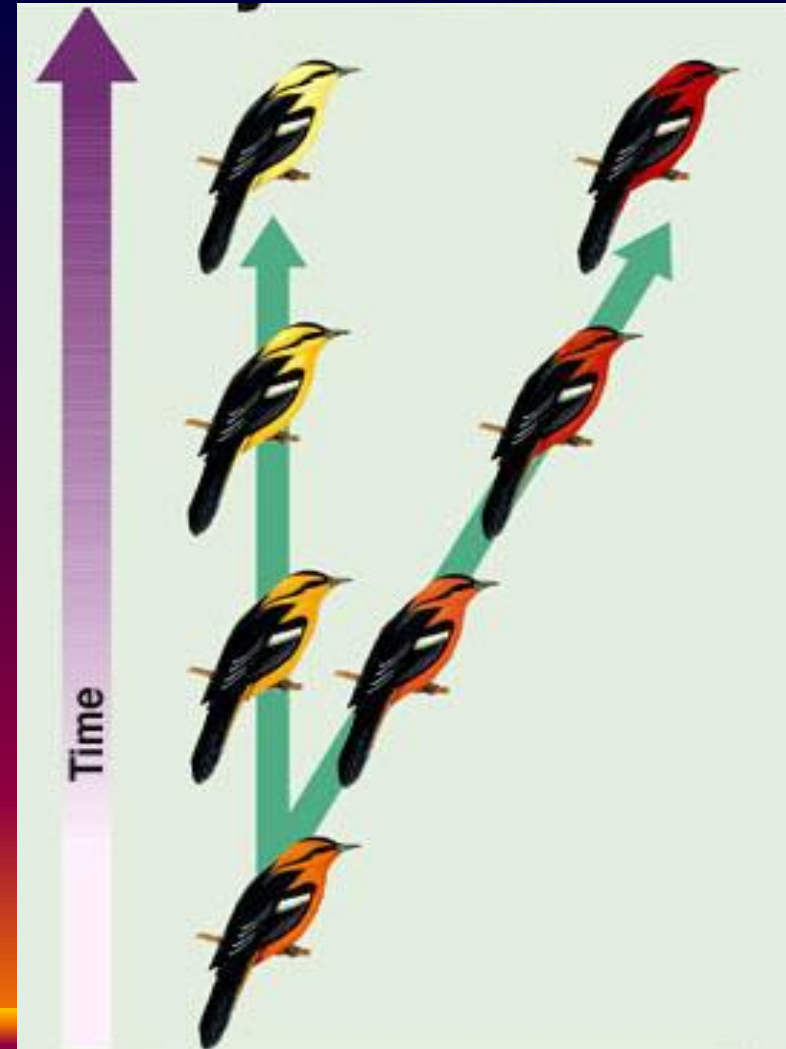
- The unequal ability of individuals to survive and reproduce leads to a gradual change in a population, with favorable characteristics accumulating over generations, leading to the creation of new species.

=ORGANISMS CHANGE OVER TIME



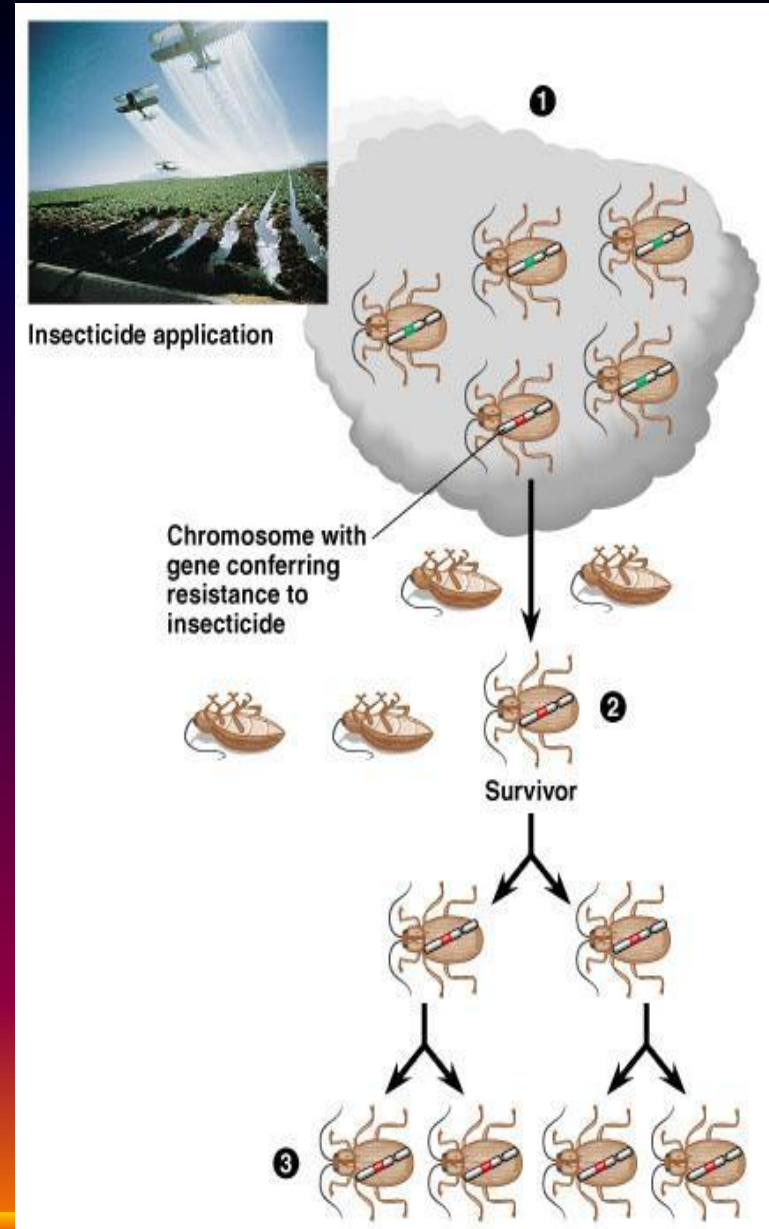
Common Descent with Modification

- Darwin proposed that organisms descended from **common ancestors**
- Idea that organisms **change with time**, diverging from a common form
- Caused **evolution of new species**



Natural Selection

- The driving force for evolution
- During the struggle for resources, strongest survive & reproduce
- Idea that at least **some of the differences** between individuals, which impact their survival and fertility, are **inheritable**



Origin of Species

Darwin Presents His Case by publishing *On the Origin of Species by Means of Natural Selection* in 1859. (25 years after his return to England)

Darwin knew That His Theory Would Be Extremely Controversial And Would Be Attacked
His Theory Challenged Established Religious & Scientific Beliefs, Particularly About The Creation Of Man

Publication of “On The Origin of Species”

- He Refused To Publish Until He Received An Essay From **Alfred Wallace**
 - Fellow Naturalist
 - **Independently Developed The Same Theory**
 - After 25 Years, Someone Else Had Come To The Same Conclusions From Their Observations Of Nature



Natural Variation and Artificial Selection

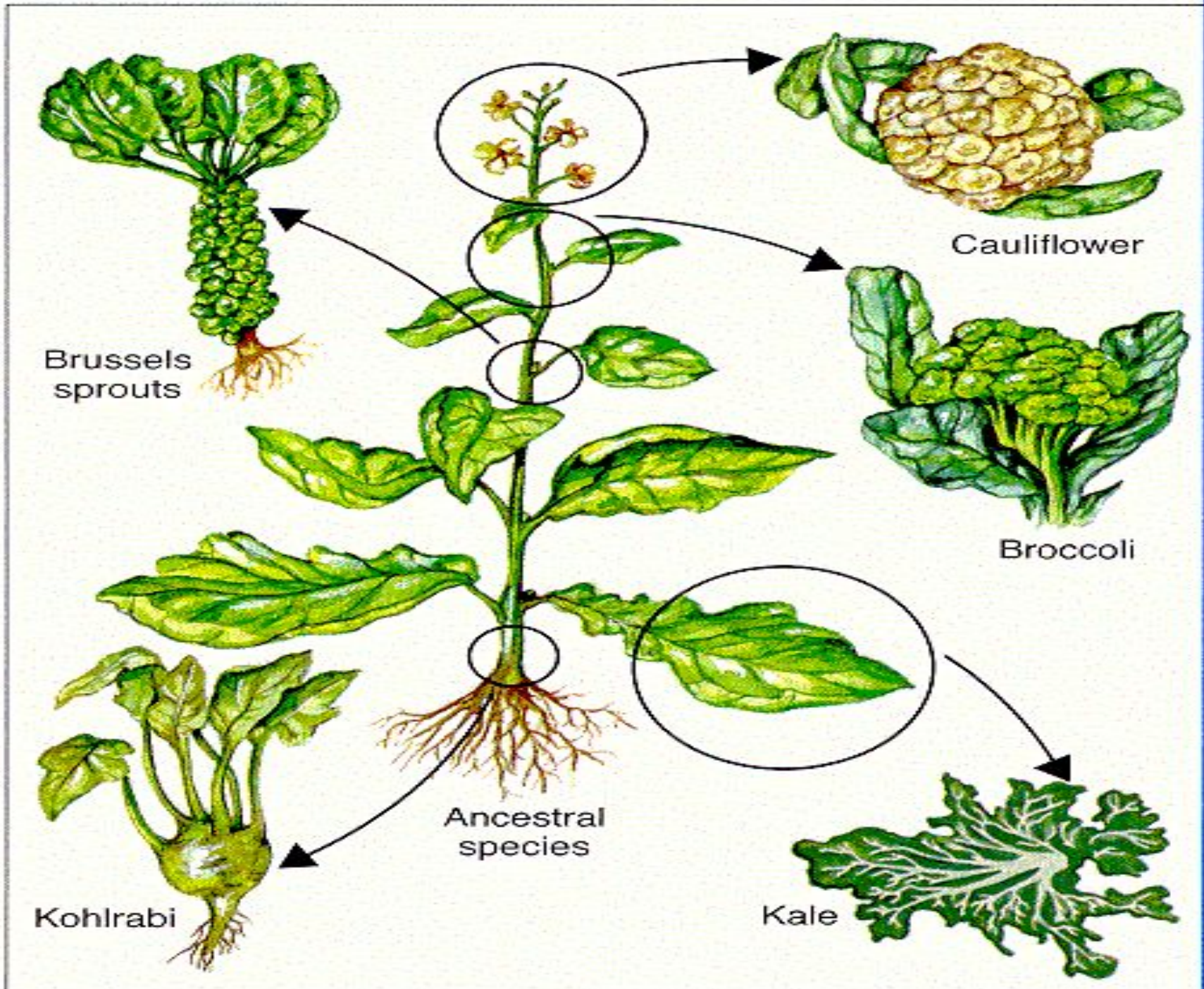
Key Concept:

In **Artificial Selection**, Nature Provided The Variation Among Different Organisms, And Humans Selected Those Variations That They Found Useful

le Dogs from Wolves

Natural Variation and Artificial Selection

- **Natural Variation**
 - Differences Among Individuals Of A Species
- **Artificial Selection**
 - Selective Breeding To Enhance Desired Traits Among Stock or Crops



Evolution By Natural Selection

Concept Summary

- →Overproduction→Variations→Inheritance
- **The Struggle for Existence** (compete for food, mates, space, water, etc.) [Competition]
- **Survival of the Fittest** (strongest able to survive and reproduce)
- **Descent with Modification** (new species arise from common ancestor replacing less fit species) “Fit genes” passed on, accumulated in a population, leading to changes in species over time.

Survival of the Fittest

- **Fitness**

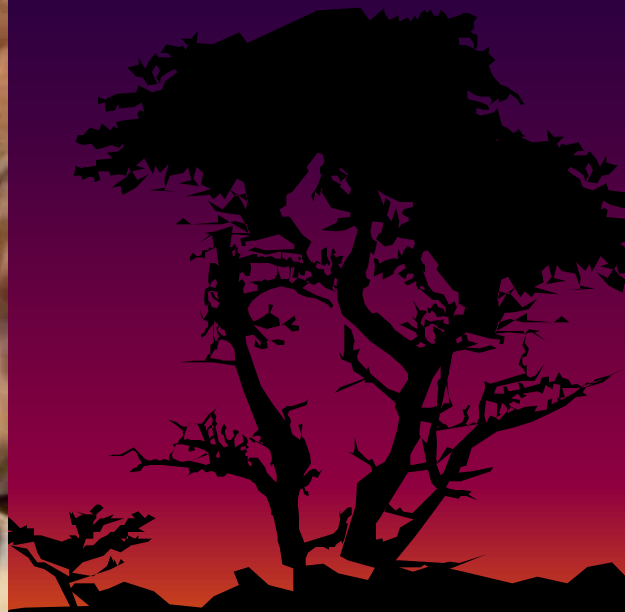
- Ability of an Individual To Survive & Reproduce
- Low fitness=death=produce few offspring=survival of the fittest

- **Adaptation**

- Inherited Characteristic That Increases an Organisms Chance for Survival

Survival of the Fittest

- **Adaptations Can Be:**
 - **Physical**
 - Speed, Camouflage, Claws, Quills, Mimicry, Resistance etc.
 - **Behavioral**
 - Solitary, Herds, Packs, Activity, etc.



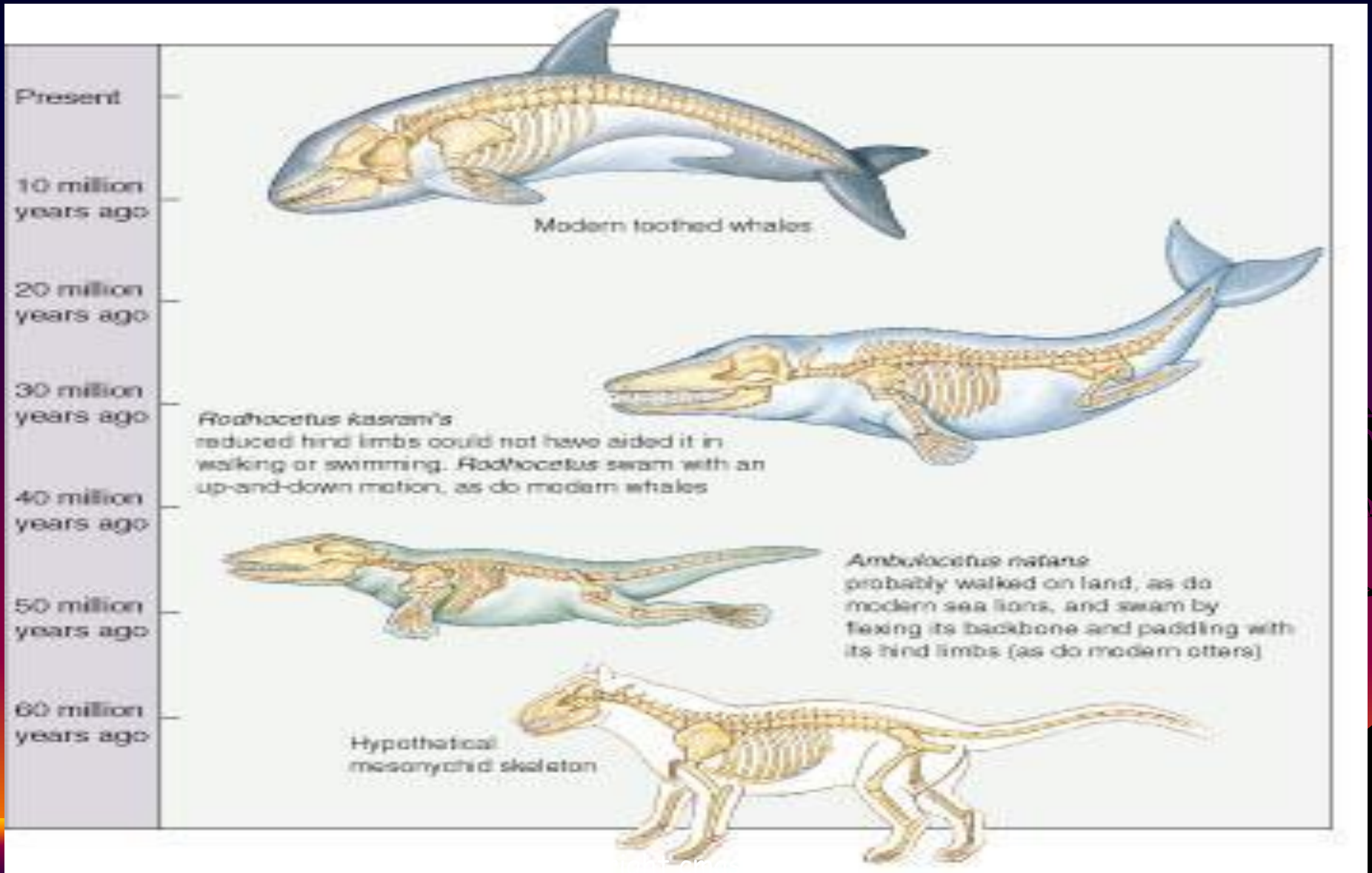
Natural Selection: Adaptations



Descent With Modification

- Takes Place Over **Long Periods** of Time
- Natural Selection Can Be **Observed** As Changes In
 - Body Structures, ecological niches, habitats
- Species **Today Look Different** From Their Ancestors
- Each Living Species Has:
 - Descended...with changes...from other species...over time
- **Implies** All Living Organisms Are Related
 - Single Tree of Life (DNA, Body Structures, Energy Sources)
- All Species, Living & Extinct, Were Derived From Common Ancestors

Descent With Modification



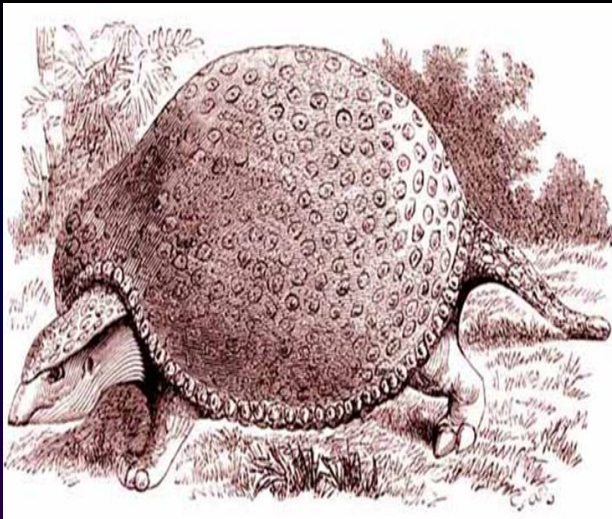
Theory of Evolution Today

Supporting Evidence

Darwin Argued That Living Things Have Been Evolving On Earth For **Millions of Years**. Evidence For This Process Could Be Found In:

- The Fossil Record
- The Geographical Distribution of Living Species
- Homologous Structures of Living Organisms
- Similarities In Early Development

Fossil Record



Glyptodont



- Earth is Billions of Years Old
- Fossils provide a record of species that lived long ago and how ancient species share similarities with species now living on Earth
- Fossils In Different Layers of Rock (sedimentary Rock Strata) Showed Evidence Of Gradual Change Over Time

Geographic Distribution of Living Species

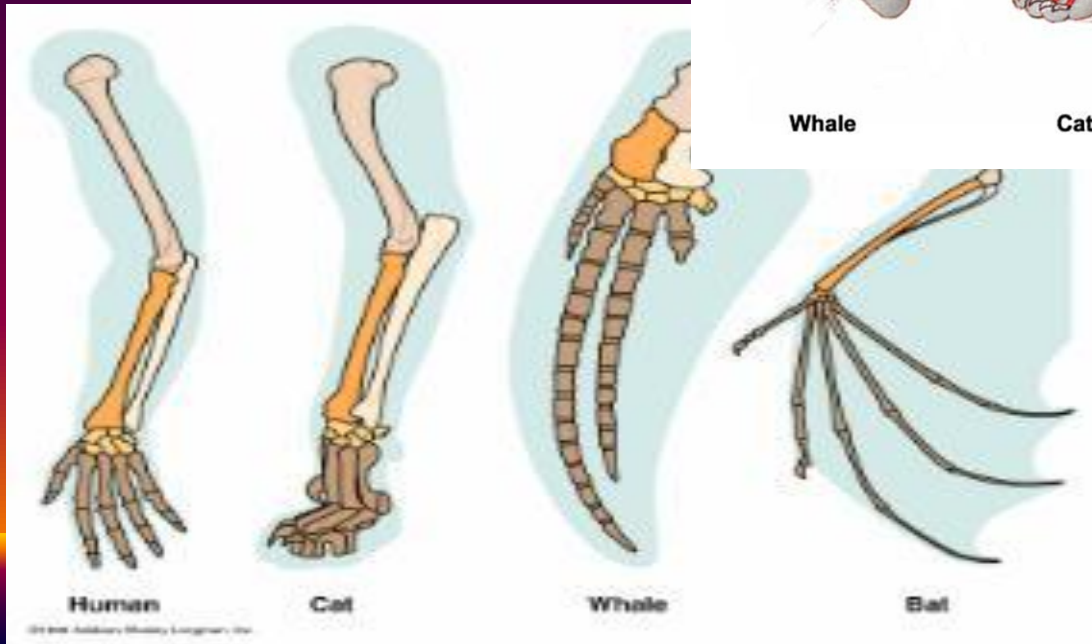
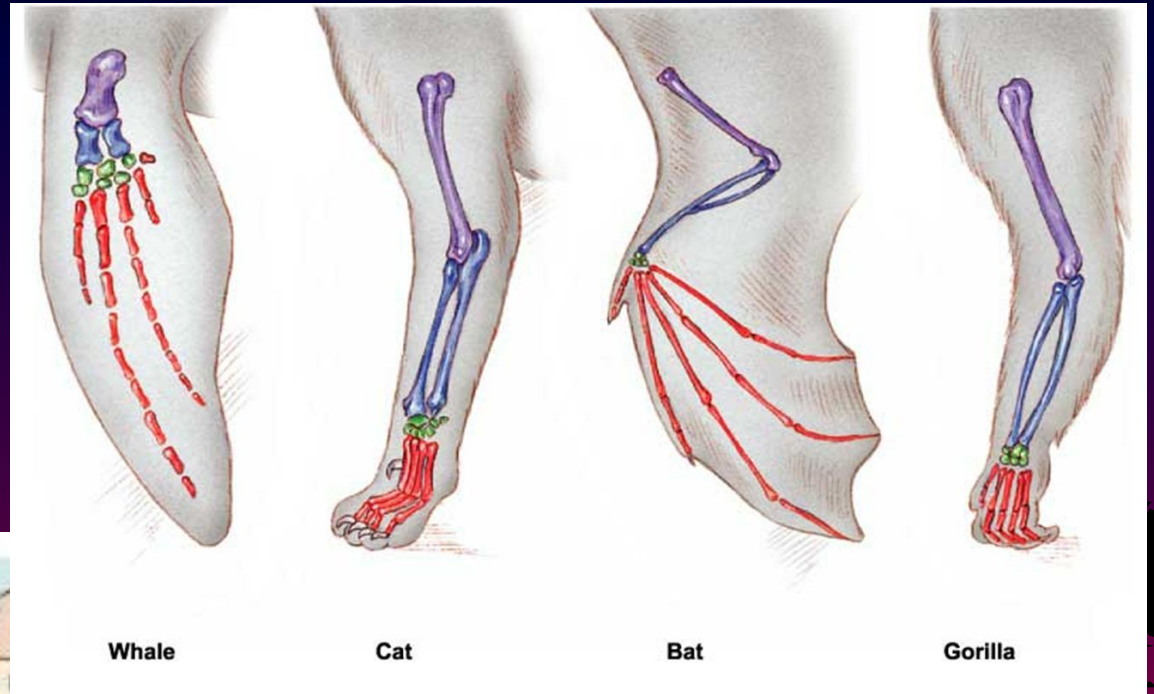
- Different Animals On Different Continents But Similar Adaptations To Shared Environments



Homologous Body Structures

- **Derived Traits:** Newly evolved features, such as feathers, that do not appear in the fossils of common ancestors
- **Ancestral Traits:** Primitive features, such as teeth and tails, that do appear in ancestral forms
- **Homologous Structures:** Anatomically similar structures inherited from a common ancestor
 - Scientists Noticed Animals With Backbones (Vertebrates) Had Similar Bone Structure
 - May **Differ In Form or Function**
 - Limb Bones Develop In Similar Patterns
 - **Arms, Wings, Legs, Flippers**

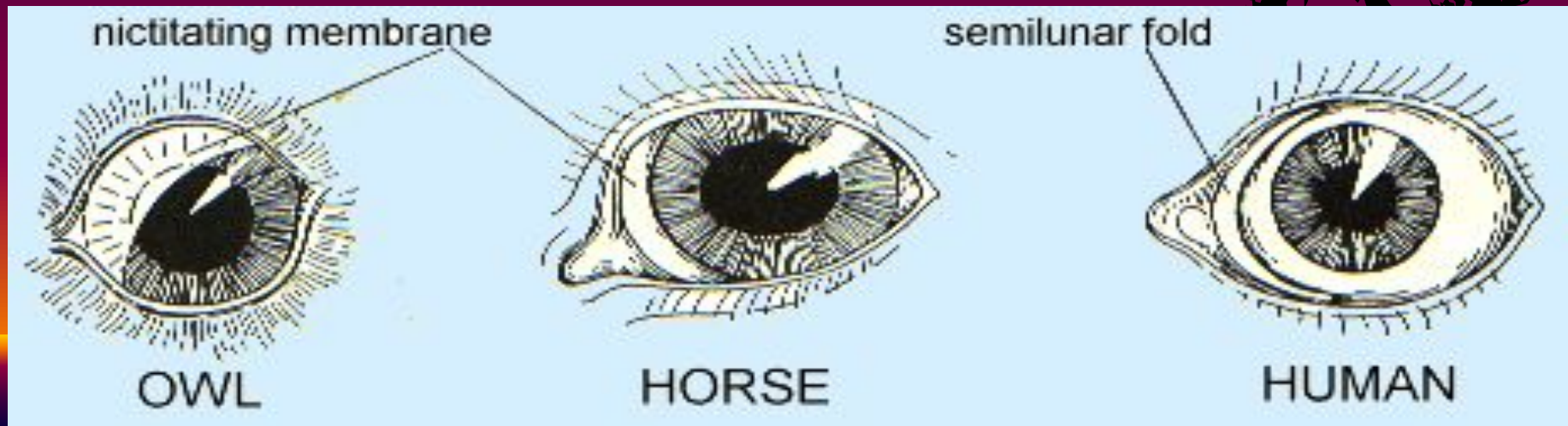
Homologous Body Structures



Homologous Body Structures

- Not All Serve Important Functions
 - Called Vestigial Organs
 - Appendix In Man
 - Legs On Skinks
 - Whales have hip bones

Features of ancestors that no longer have a function for that species will become smaller over time until they are lost



Analogous Structures

- Can be used for the same purpose and can be superficially similar in construction, but are not inherited from a common ancestor
 - Wings on a bird vs an insect
- Shows that functionally similar features can evolve independently in similar environments.

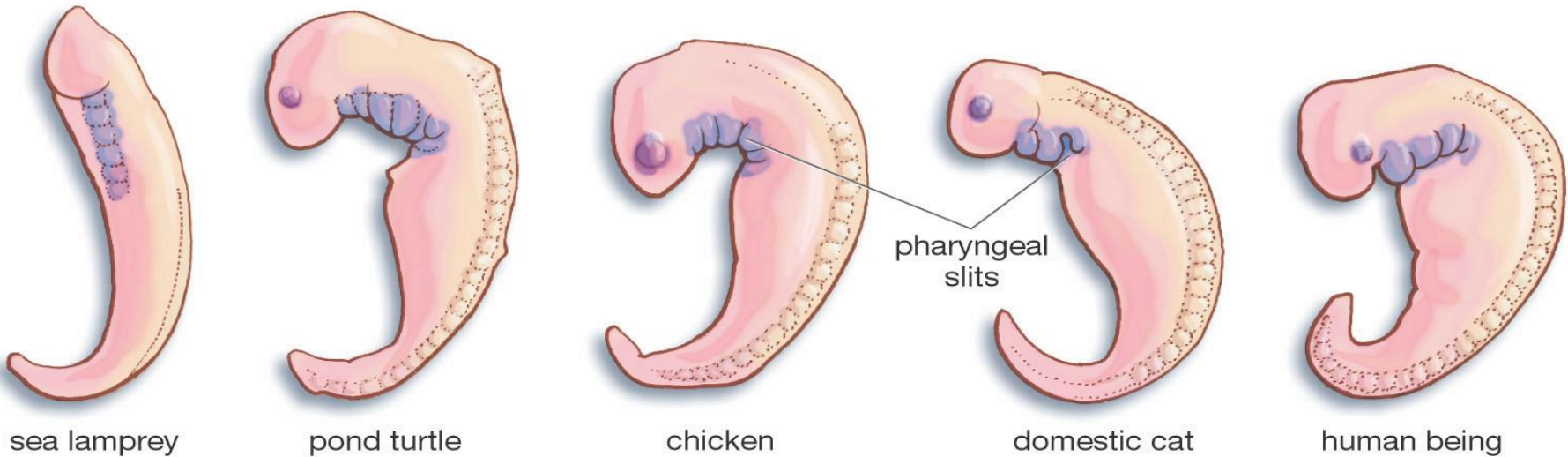
Similarities In Early Development

- Embryonic Structures Of Different Species Show Significant Similarities
- **Embryo** – early stages of vertebrate development

Similarities In Embryonic Development

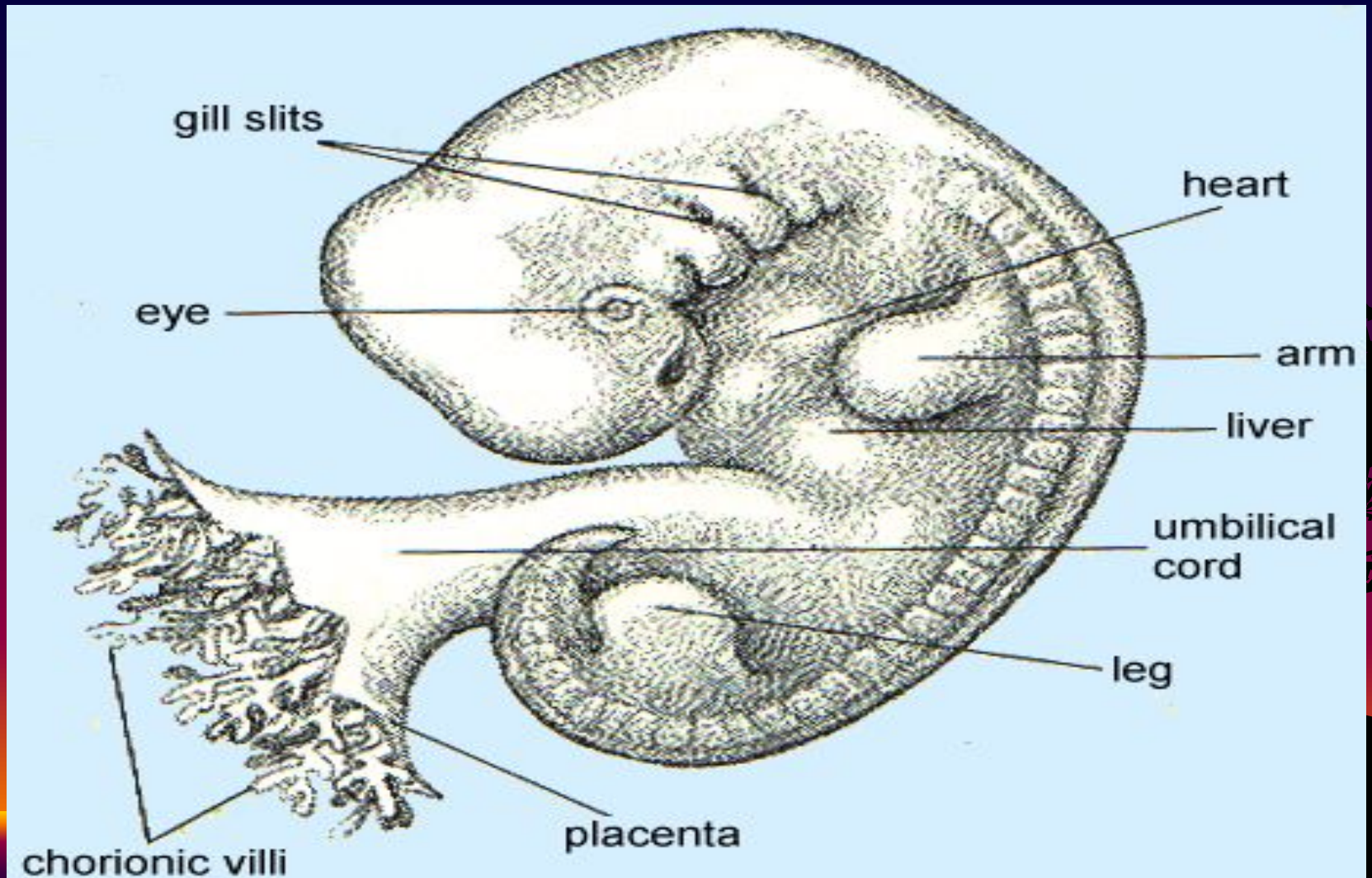
Evidence for Evolution - Comparative Embryology
=Vertebrate embryos exhibit homologous structures during certain phases of development but become totally different structures in the adult forms.

Pharyngeal slits exist in these five vertebrate animals ...

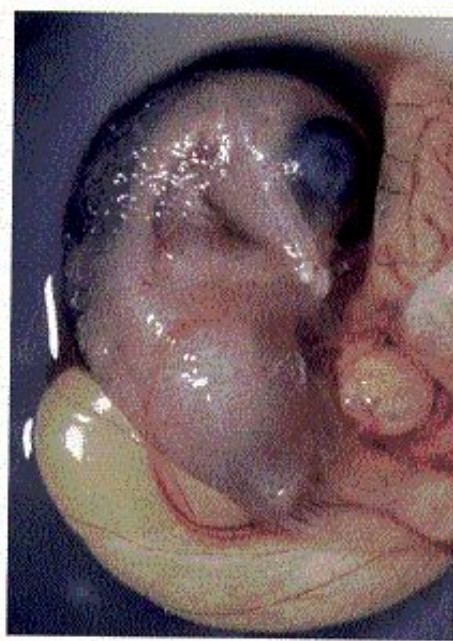


... evidence that all five evolved from a common ancestor.

Human Fetus – 5 weeks

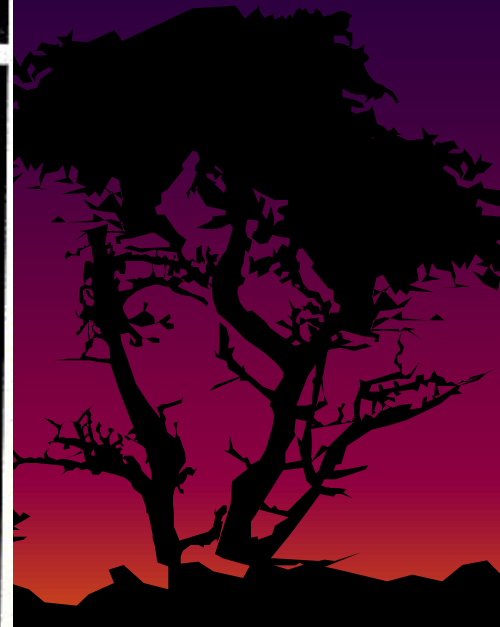


Chicken



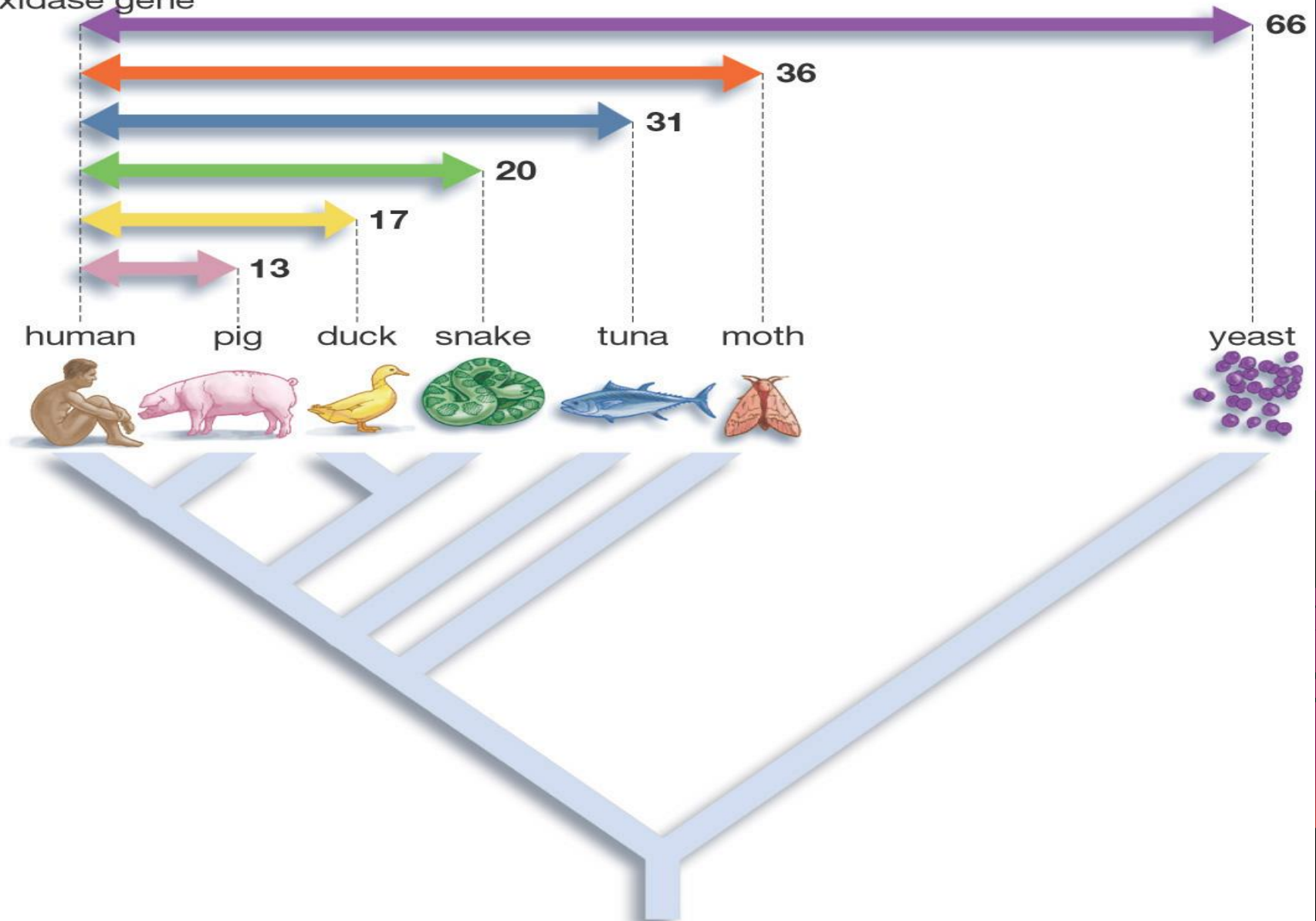
Turtle

Rat



Number of DNA nucleotide base differences in the cytochrome oxidase gene

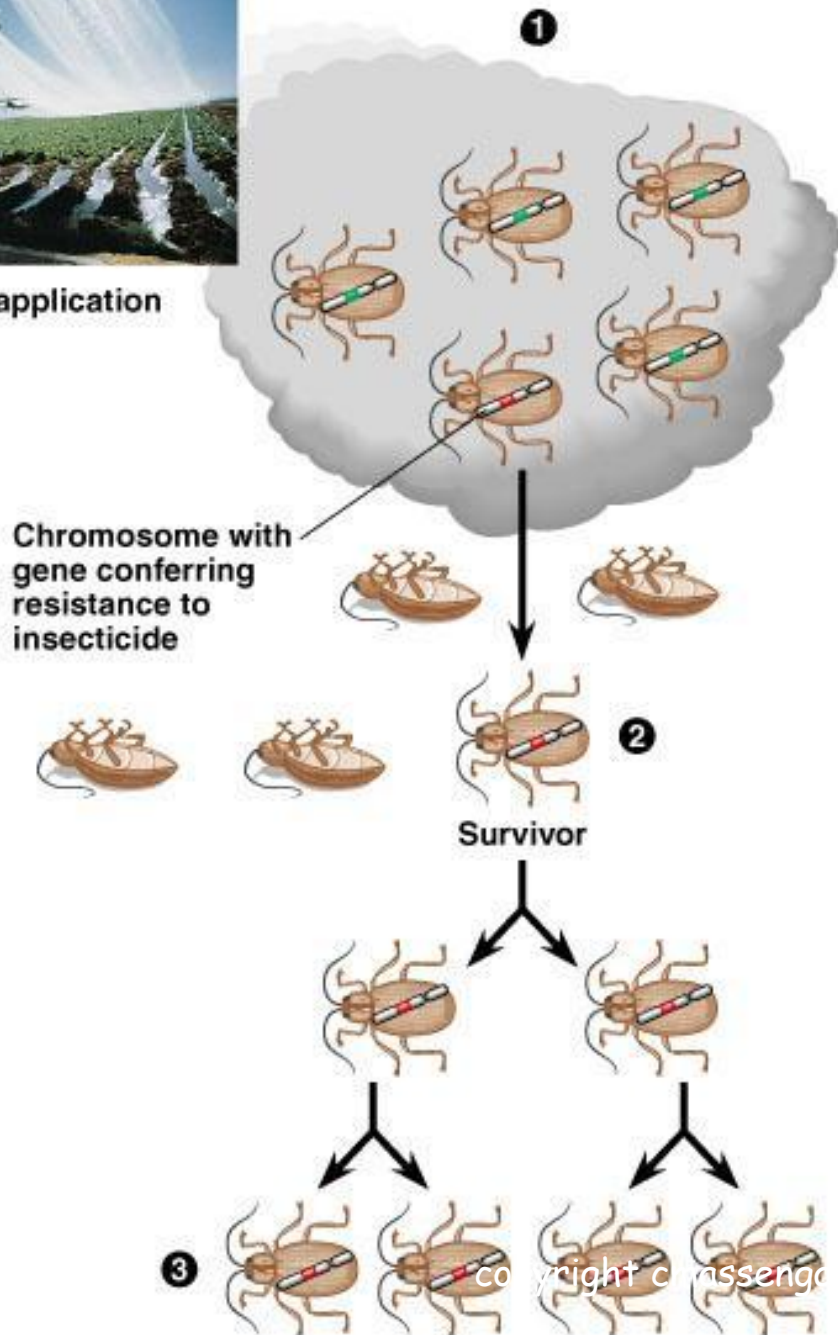
c



Similarities in DNA Sequence



Insecticide application



Evolution of pesticide resistance in response to selection

Summary of Darwin's Theory

- 1. Individual Organisms In Nature Differ From One Another. Some Of This Variation Is Inherited**
- 2. Organisms In Nature Produce More Offspring Than Can Survive, And Many Of These Offspring Do No Reproduce**

Darwin's Theory

3. Because More Organisms Are Produced Than Can Survive, Members Of Each Species Must Compete For Limited Resources
4. Because Each Organism Is Unique, Each Has Different Advantages & Disadvantages In The Struggle For Existence

Darwin's Theory

- 5. Individuals Best Suited To Their Environment Survive & Reproduce Successfully – Passing Their Traits To Their Offspring.**
- 6. Species Change Over Time. Over Long Periods, Natural Selection Causes Changes That May Eventually Lead To New Species**

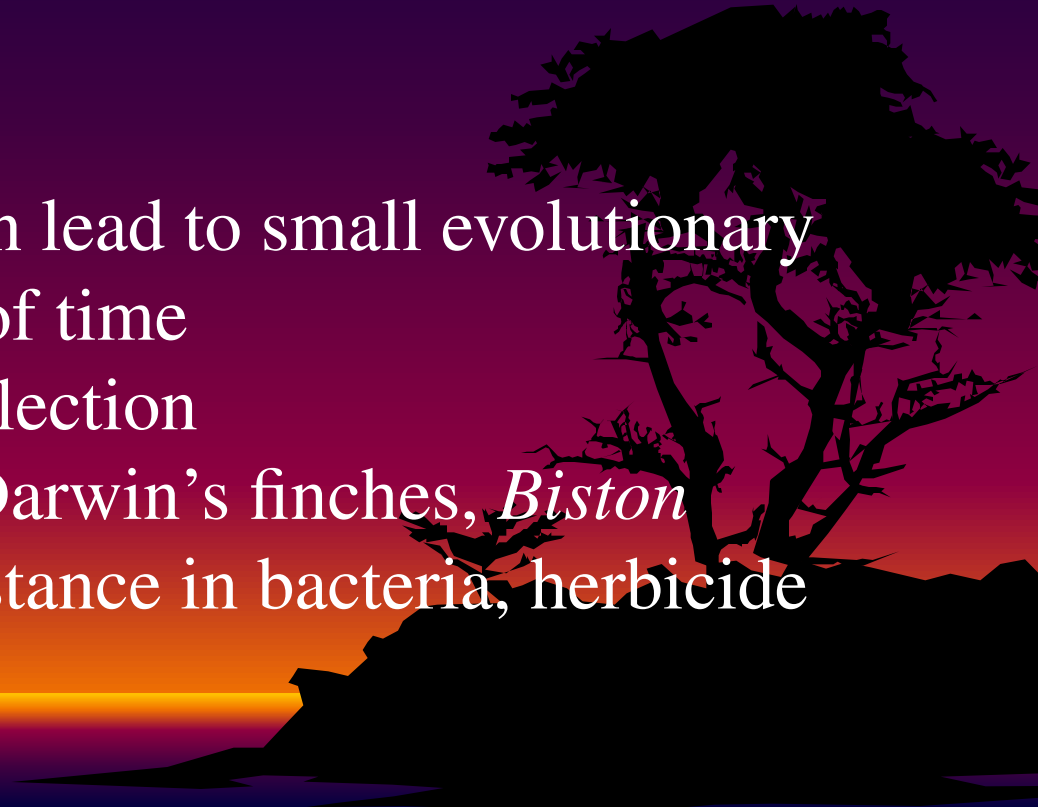
Darwin's Theory

7. Species Alive Today Have Descended With Modifications From Species That Lived In The Past
8. All Organisms On Earth Are United Into A Single Tree Of Life By Common Descent

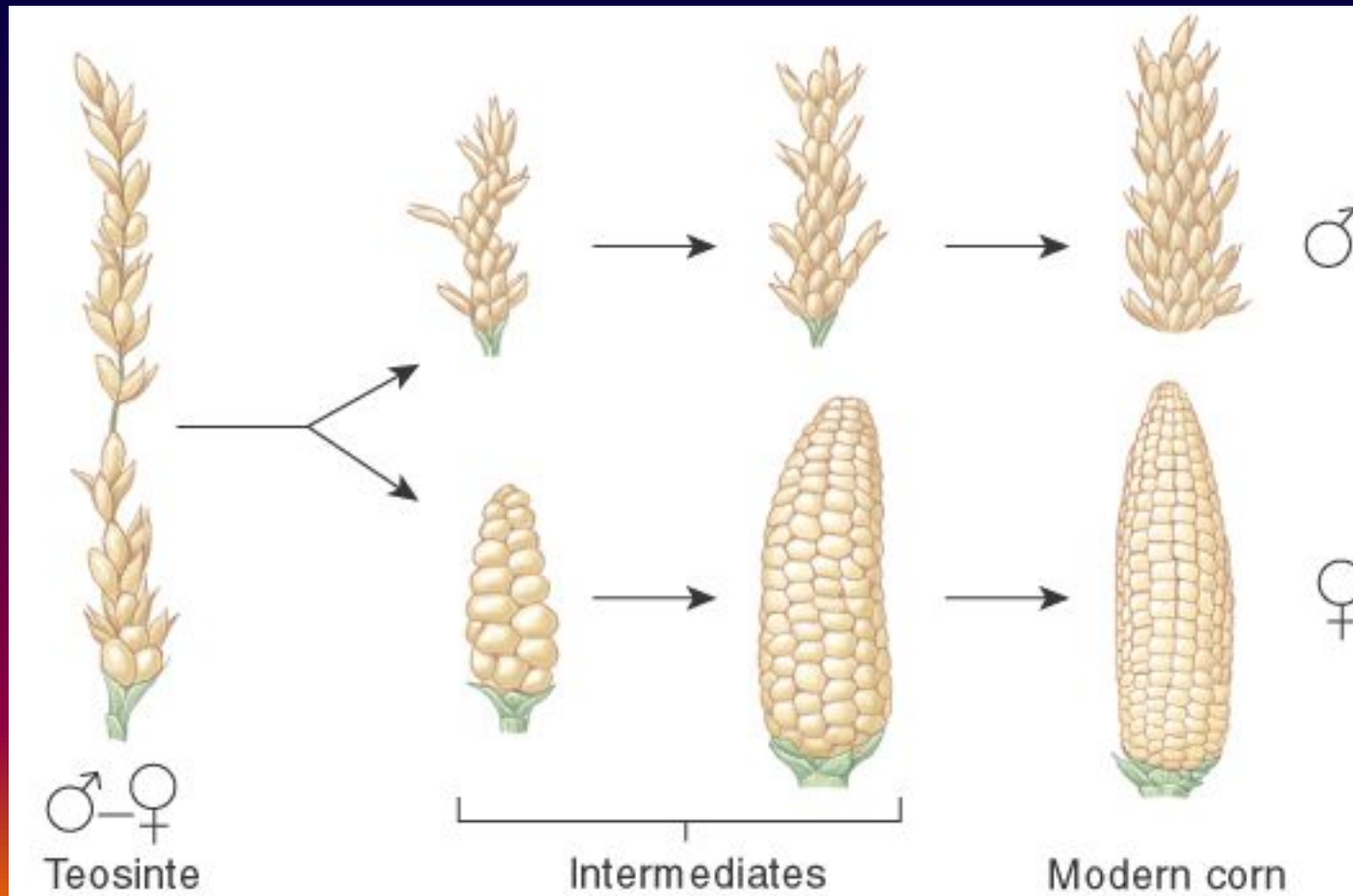
MORE EXAMPLES

Can selection produce evolutionary change?

- Hypothesis: Natural selection is the primary mechanism through which organisms have evolved over long periods of time
- Prediction: selection can lead to small evolutionary changes in short periods of time
 - example - artificial selection
 - direct observations: Darwin's finches, *Biston* moths, antibiotic resistance in bacteria, herbicide resistance in weeds



Artificial Selection



Biston Moths: a Classic example

Selection in peppered moths in England

2 genetically determined phenotypes: black, mottled white

Prior to 1600 (industrial revolution)

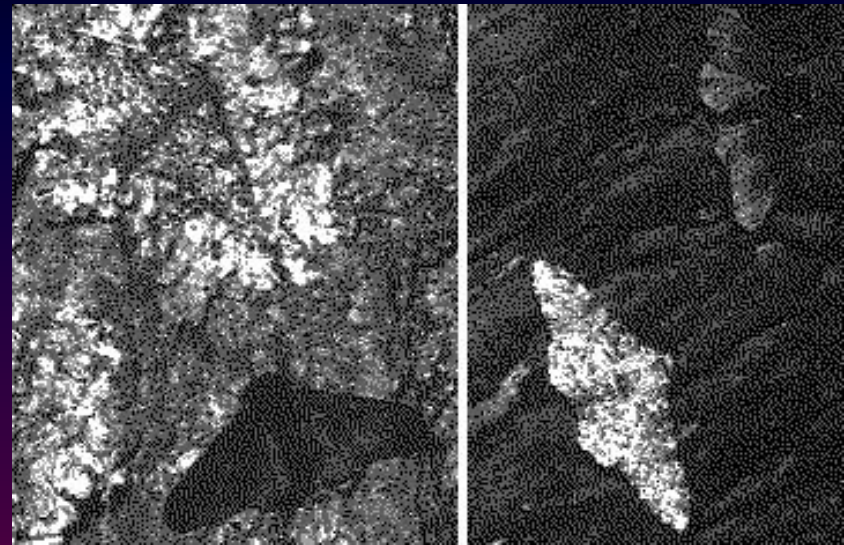
black form approximately 1%
white form approximately 99%

After 1600 (widespread pollution, smoke and soot)

black form approximately 90%
white form approximately 10%

Now (local pollution from smokestacks)

	Near Pollution	Away
black form	50%	10%
white form	50%	90%

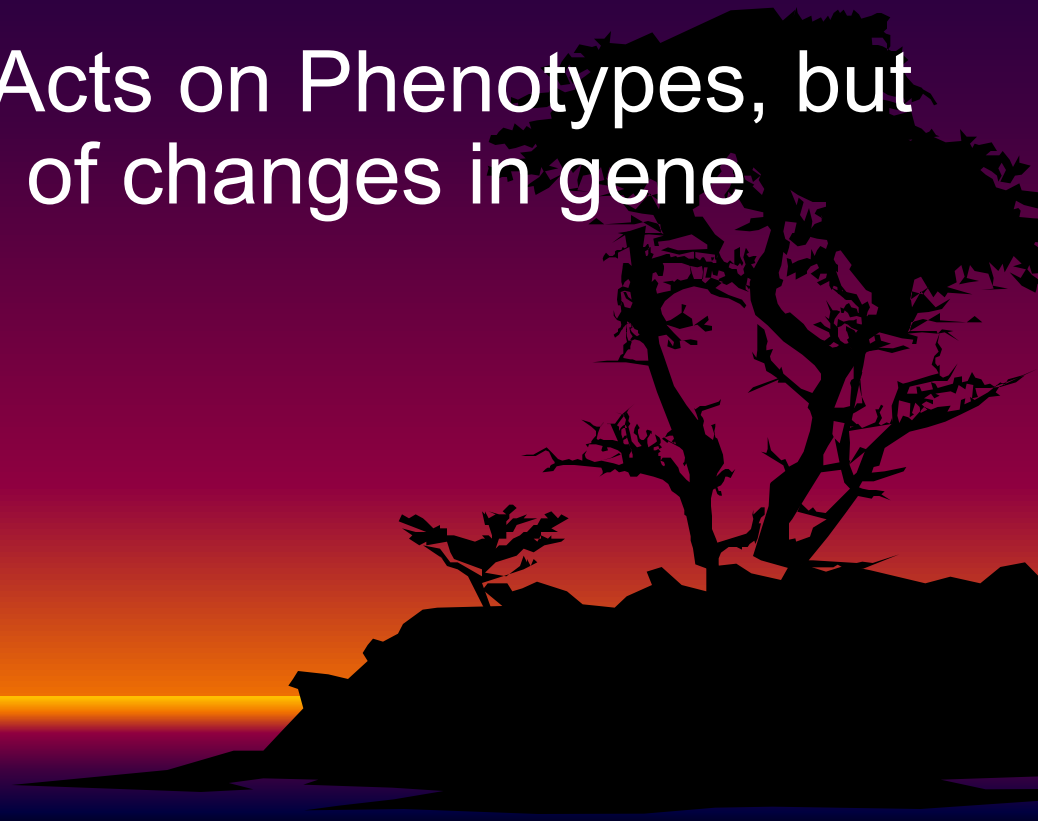


An example of Natural Selection in Action: Galápagos Finches



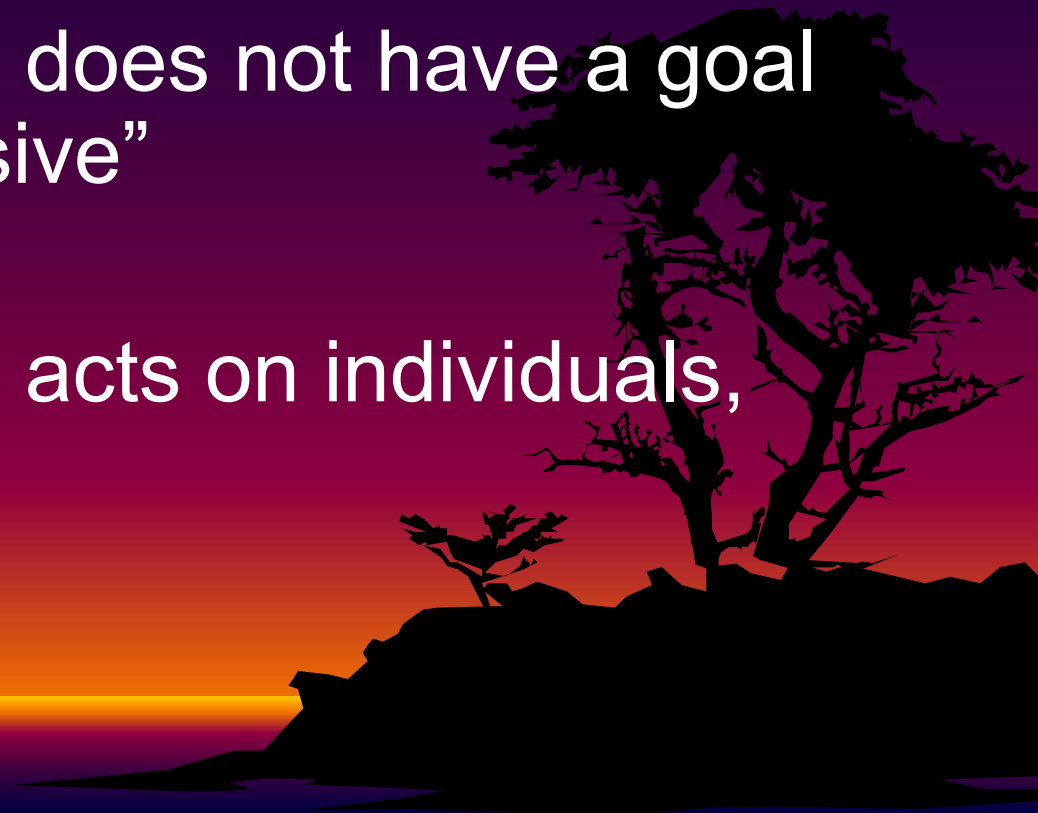
Implications of Natural Selection

- Natural selection acts on individuals, but its consequences occur in populations
- Natural Selection Acts on Phenotypes, but Evolution consists of changes in gene frequencies



Implications of Natural Selection

- Natural Selection acts on existing traits
- Natural Selection does not have a goal nor is it "progressive"
- Natural Selection acts on individuals, not groups

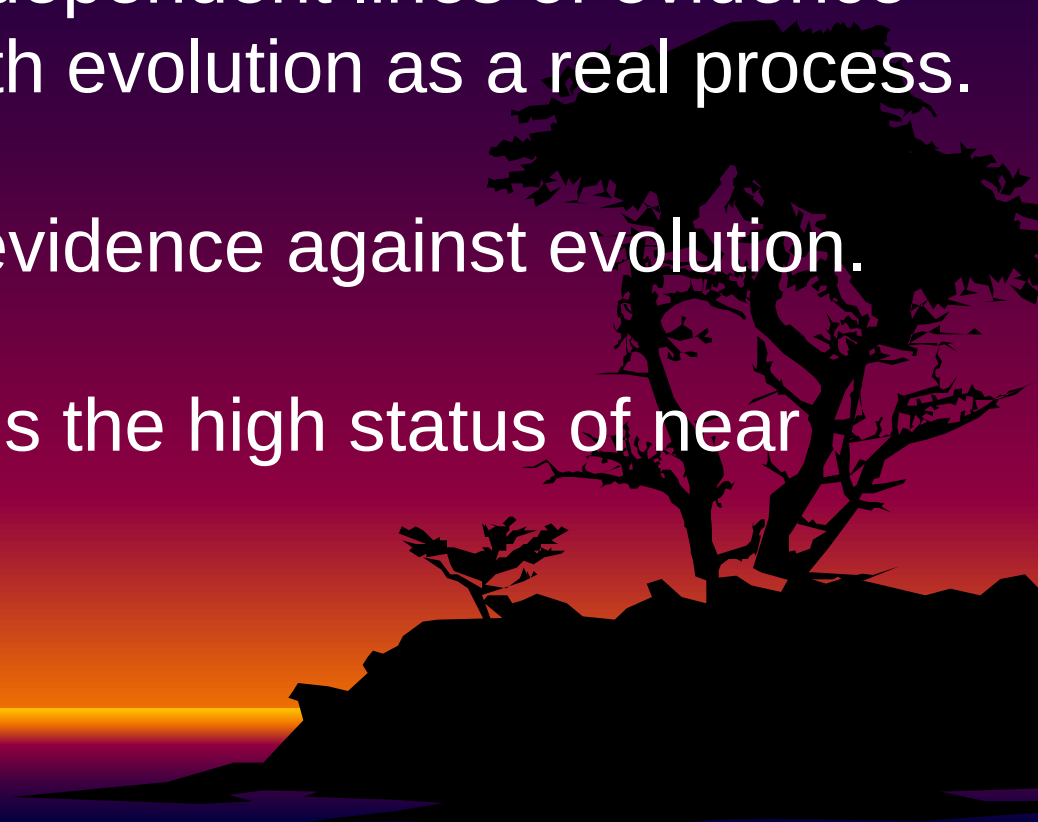


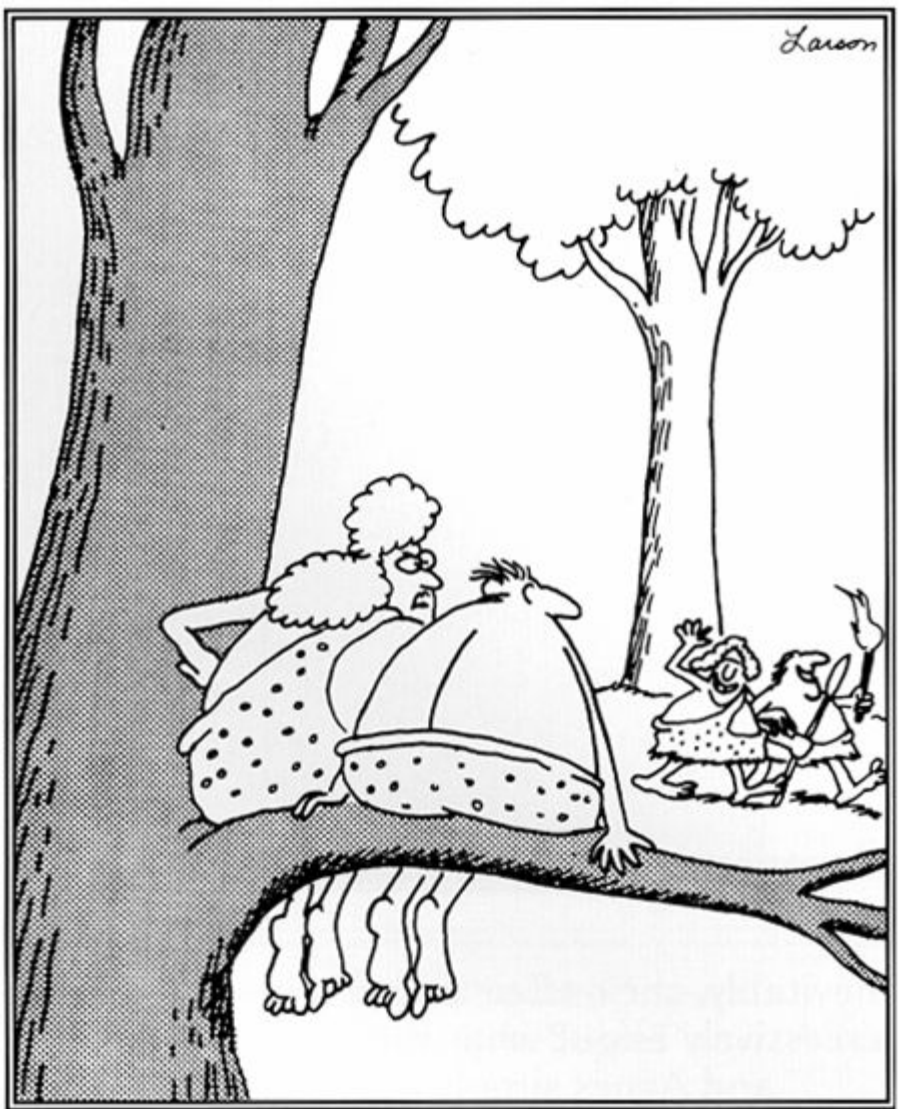
The idea of evolution was developed from many observations of life. It has been tested and challenged many times and in many ways, and has survived in great shape.

There are also many independent lines of evidence which are consistent with evolution as a real process.

There is NO observed evidence against evolution.

Evolution therefore holds the high status of near certainty.





Common Misperception:

Individuals
evolve

“And now there go the Wilsons!... Seems
Like everyone’s evolving except us!”

Common Misperception:

Acquired characteristics
are not inherited!



Classroom Assignment:

Building the Perfect Beast

- I want you to think about how life forms have evolved over time, and how they might have evolved better.
- Today you are in charge of the world, and you have to think about ways to make species better adapted to the environment.



Building the Perfect Beast

- Pick Six Characteristics of Humans that you think should be improved (*height, speed, vision, etc.*)
- Design a new human, describing your six improvements in detail, writing a short paragraph for each improvement



END OF PART 1 (Chapter 10)



Start of Ch.11 info...make additions

Add from "ch 11-12"

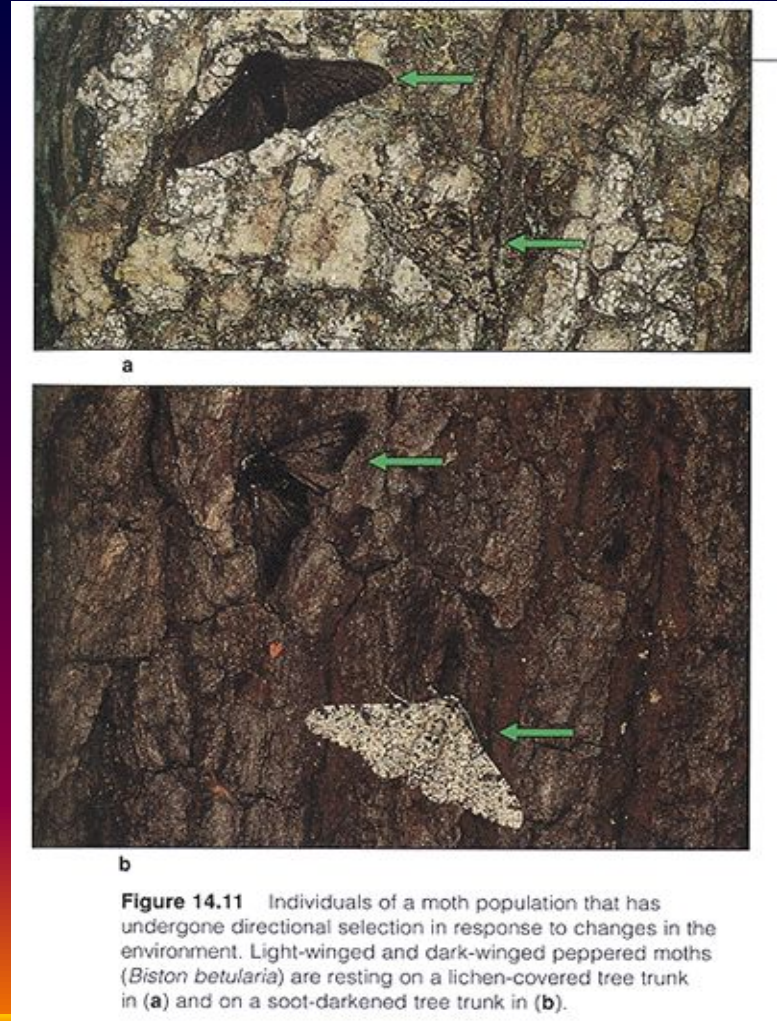


Natural Selection in Populations

Microevolution:

Small changes within a species that lead to new traits (gen to gen) in a population

- Stabilizing Selection
- Directional Selection
- Disruptive Selection



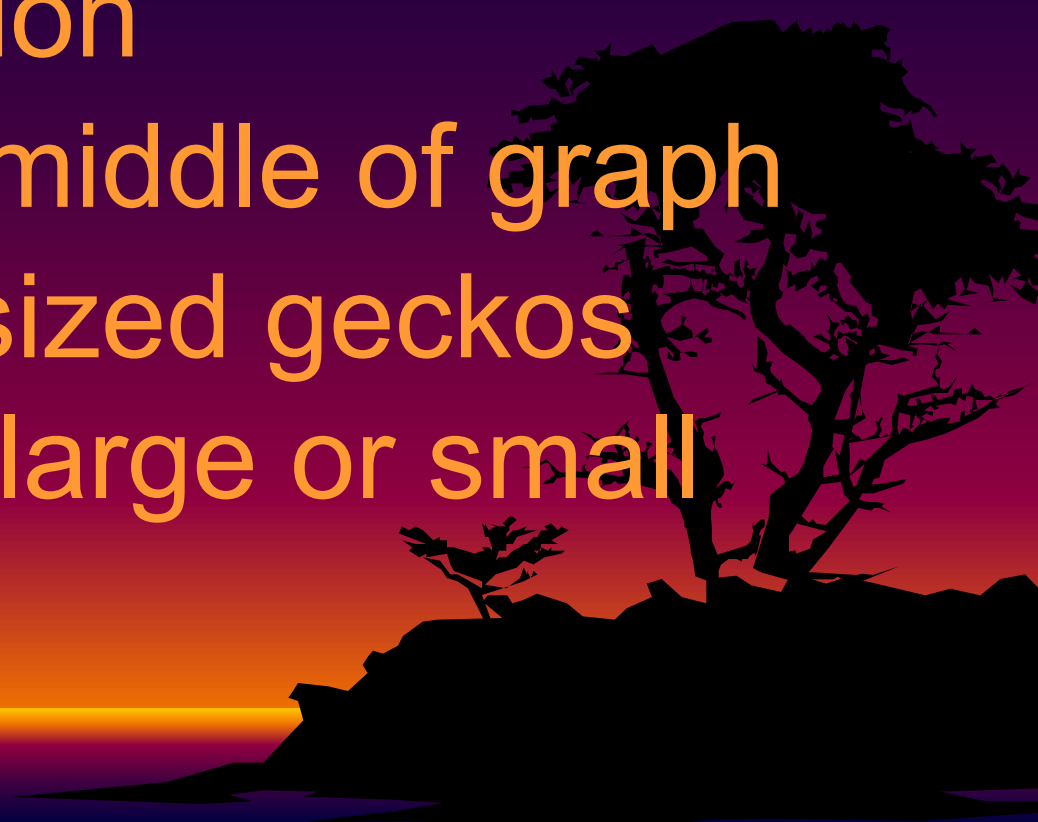
Stabilizing Selection

Favors the average individuals in the population

-increases in middle of graph

-ex: medium sized geckos

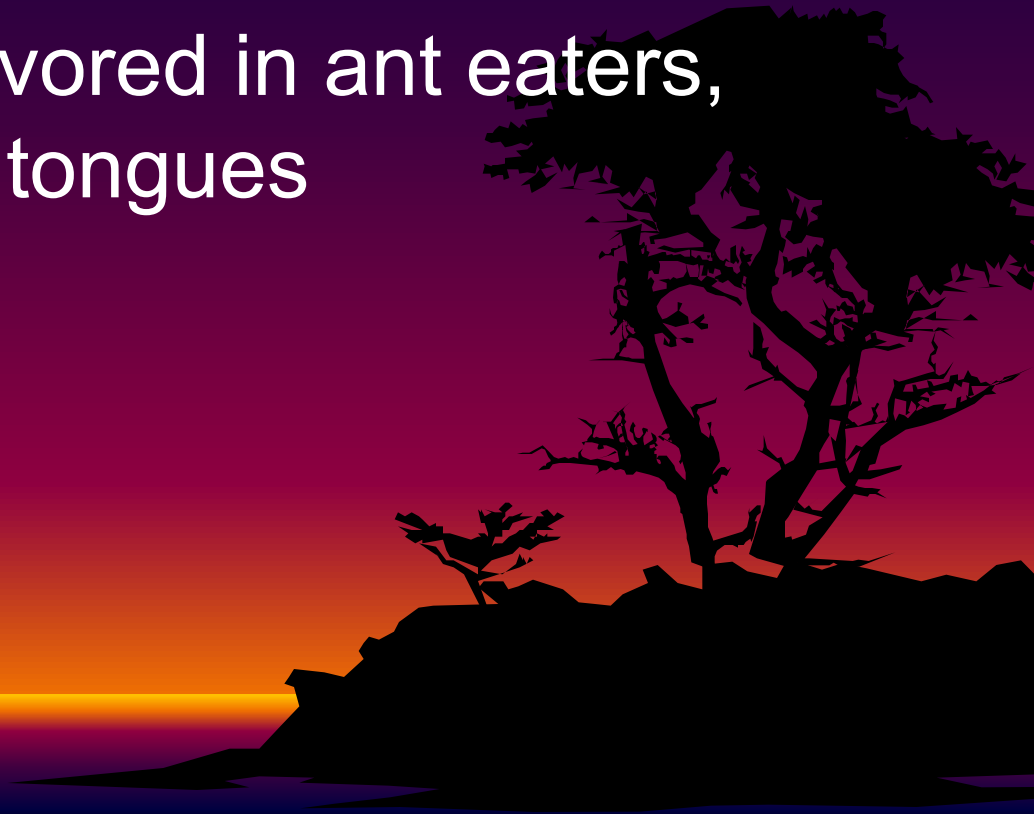
avored, over large or small geckos



Directional Selection

favors one extreme variation of a trait

ex: long tongues favored in ant eaters,
over medium/short tongues



Disruptive Selection

favors both extreme variations of a trait
ex: light and dark colored snail shells
favored, over medium colored shells



Natural Selection in Populations

Macroevolution:

large changes that can lead to new species being formed

- Convergent Evolution
- Divergent Evolution
- Coevolution



Convergent Evolution

where unrelated species develop similar adaptations to allow them to survive in similar environments

ex: emu, ostrich, and rhea all live in grassland habitats in different parts of the world



Divergent Evolution (Adaptive Radiation)

where one or more species evolves from a single species (Common ancestor)

ex: darwins finches, many species with different beaks evolved from one ancestor finch



Coevolution

organisms that live in close association
adapt to one another's existence

ex: predator-prey as prey gets faster to
escape, predator becomes faster to catch
prey



Population Genetics & Evolution

Speciation

