

Explain: Biodiversity & Evolution KEY

SPRING SEMESTER 2024



INSTRUCTOR:

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Vocabulary / Key Terms/ Concepts	Biodiversity & Evolution Notes
<ul style="list-style-type: none">• <i>Adaptation</i>• <i>Anatomical Homology</i>• <i>Biogeography</i>	<p>Student Expectations:</p> <ul style="list-style-type: none">• Identify evidence of common ancestry from the fossil record, biogeography, and homologies (anatomical, molecular, developmental).• Describe different rates of evolutionary change, such as gradualism, abrupt appearance, and stasis.• Explain how natural selection affects populations rather than individuals.• List the key elements of natural selection: inherited variation, overproduction of offspring, competition for resources, and differential reproductive success.• Recognize how natural selection can lead to the formation of new species (speciation).• Define evolutionary mechanisms beyond natural selection, including genetic drift, gene flow,

- *Bottleneck Effect*

- *Competition for Resources*

- *Differential Reproductive*

Success

- *Directional Selection*

- *Disruptive Selection*

- *Environmental Conditions*

- *Evolution*

mutation, and genetic recombination.

- **Summarize** the process of evolution, including factors like population growth potential, genetic variation, competition, and survival of the fittest.
- **Identify** the impacts of changing environmental conditions on species, such as increases in population, speciation, and extinction.

I. Charles Darwin and the Origin of Species

A. Who Was Charles Darwin?

- A **naturalist** and **biologist** who developed the theory of evolution by natural selection.
- Published "*On the **Origin of Species***" in 1859, explaining how species change over time.

B. The Journey on the HMS Beagle

- Darwin traveled around the world from 1831–1836 on the **HMS Beagle**.
- Visited places like the **Galápagos** Islands, South America, and Australia.
- Observed and collected plants, animals, and fossils.



C. Key Discoveries

- *Fossil Record*

- *Gene Flow*

- *Genetic Drift*

- *Genetic Recombination*

- *Gradualism*

- *Inherited Variation*

- *Mutation*

- *Natural Selection*

- **Adaptations:** Traits that help organisms survive in their environment.
 - **Finches** on the Galápagos Islands: Beak shapes varied depending on the type of food available.
 - **Tortoises:** Shell shapes were different based on the island's environment.
- **Fossil Evidence:** Fossils of extinct animals resembled living species.



D. Early Theories

- **Common Descent:** All species share a **common ancestor**.
- **Natural Selection:** Organisms with traits that help them **survive reproduce** more, passing those traits to their **offspring**.

II. Theories on the Origin of Life

A. Abiogenesis (Origins of Life)

- Life arose from non-living matter over 3.5 billion years ago.
- Miller-Urey Experiment (1953): Simulated early Earth conditions and produced amino acids, key building blocks of life.

- *Overproduction of*

Offspring

- *Punctuated Equilibrium*

- *Speciation*

- *Stabilizing Selection*

- *Stasis*

- *Survival of the Fittest*

B. Endosymbiotic Theory

- Explains how complex cells (**eukaryotes**) evolved from simple cells (**prokaryotes**).
- **Key Idea:** Larger cells engulfed smaller ones, which became **organelles** like **mitochondria** and **chloroplasts**.
- **Evidence:**
 - Mitochondria and chloroplasts have their own **DNA**, similar to **bacteria**.
 - They reproduce **independently** within cells.



III. Evidence of Evolution

A. Fossil Record

- **Fossils show how species have changed over time.**
 - **Fossils** in older rocks look very different from modern species.
 - **Intermediate Fossils:** Show **links** between major

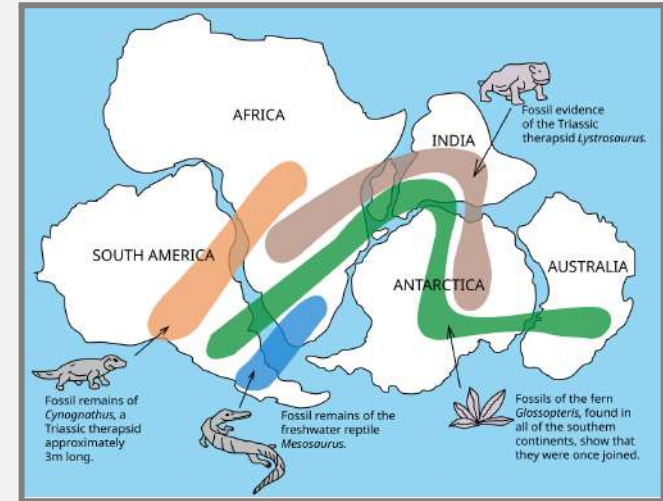


groups, like *Tiktaalik*, which connects fish and amphibians.

- **Law of Superposition:** **Older** fossils are **deeper** in the earth while **younger** fossils appear near the **surface**

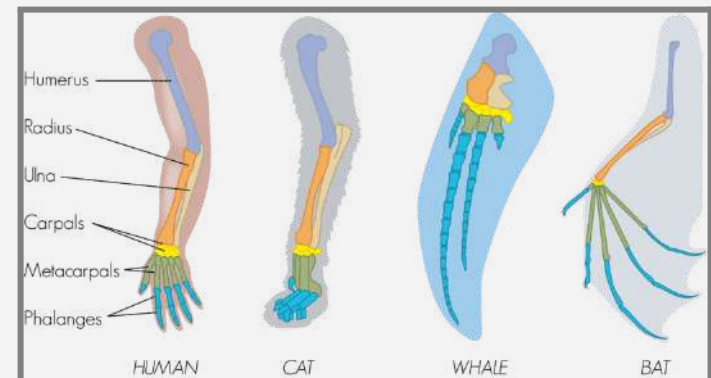
B. Biogeography

- **Study of where species live and how they got there.**
 - **Example:** Marsupials like kangaroos in Australia suggest **common ancestry** due to geographic isolation.
 - **Endemic Species:** Found only in **specific** places, like finches on the Galápagos.












C. Homologies

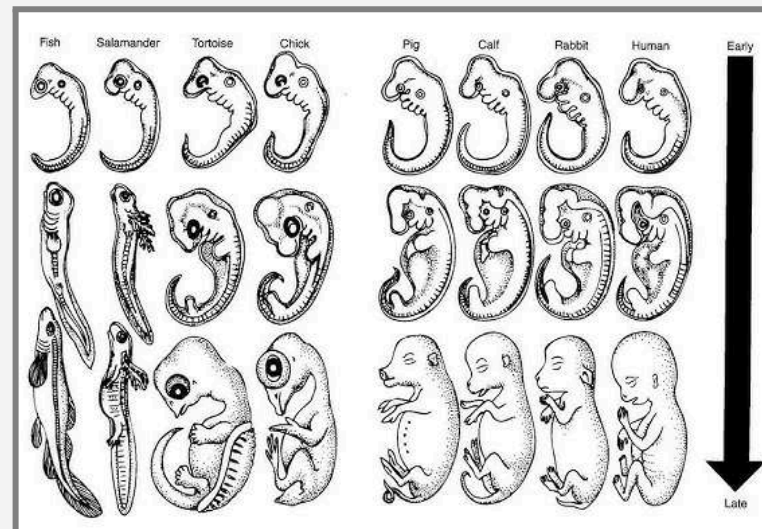
- **Traits shared by species because they came from a common ancestor.**
 1. **Anatomical Homologies:** **Similar structures**, like the bones in a whale's fin and a human hand.



2. **Molecular Homologies: Similar DNA or proteins**
(e.g., fewer differences in cytochrome c in closely related species).

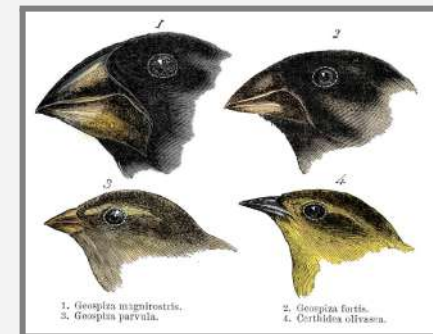
Cytochrome c Evolution		
Organism	Number of amino acid differences from humans	
 Chimpanzee	0	
 Rhesus monkey	1	
 Rabbit	9	
 Cow	10	
 Pigeon	12	
 Bullfrog	20	
 Fruit fly	24	
 Wheat germ	37	
 Yeast	42	

3. **Developmental Homologies: Embryos** of different animals (e.g., humans and chickens) look **similar** during early stages.



D. Patterns of Evolution

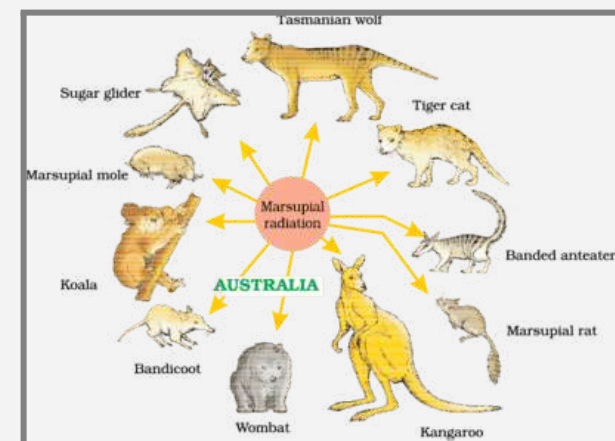
- **Convergent Evolution:** Unrelated species develop similar traits because they live in similar environments.
 - **Example:** Wings of birds and bats.
- **Divergent Evolution:** Related species evolve different traits due to different environments.
 - **Example:** Darwin's finches with varied beak shapes.
- **Adaptive Radiation:** One species evolves into many to fill different roles in an environment.
 - **Example: Australian Marsupials** – Different marsupial species evolved to fill ecological roles similar to placental mammals found elsewhere.



IV. Natural Selection

A. Key Concepts

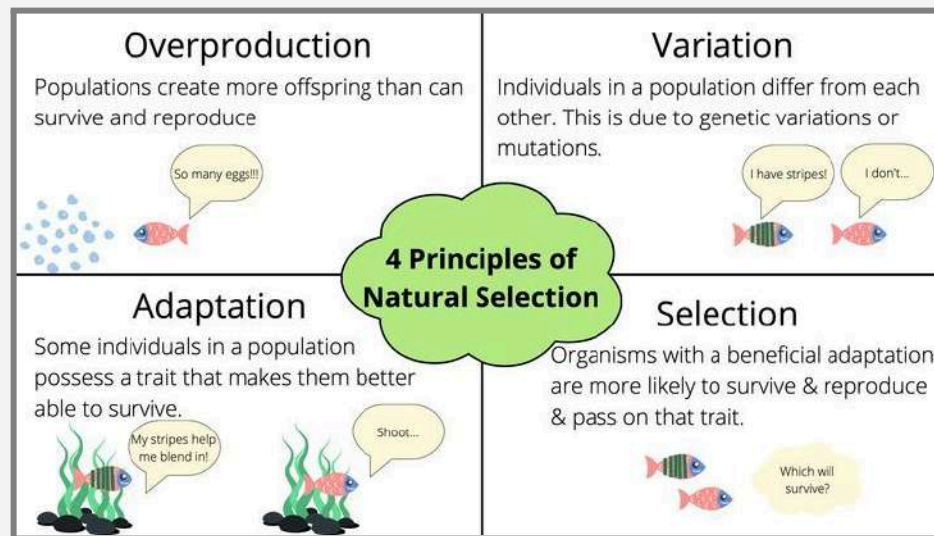
- **Definition:** The process where organisms with helpful traits survive and



reproduce.

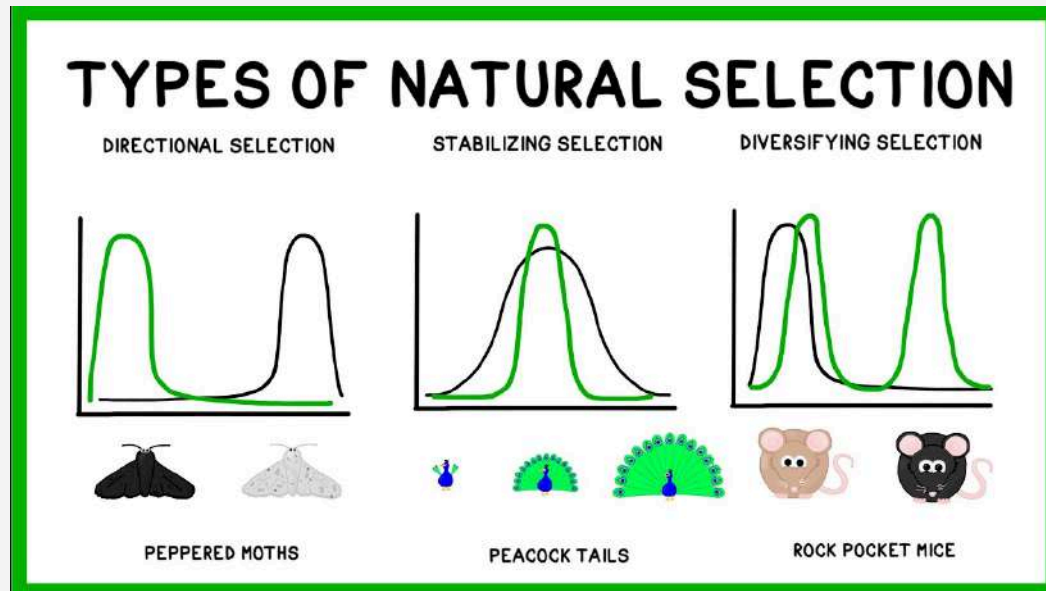
- **Key Elements:**

1. **Inherited Variation:** Traits are passed from parents to offspring.
2. **Overproduction of Offspring:** More offspring are born than can survive.
3. **Competition for Resources:** Organisms struggle for food, water, and space.
4. **Differential Reproductive Success:** Organisms with the best traits have more babies.



B. Types of Selection

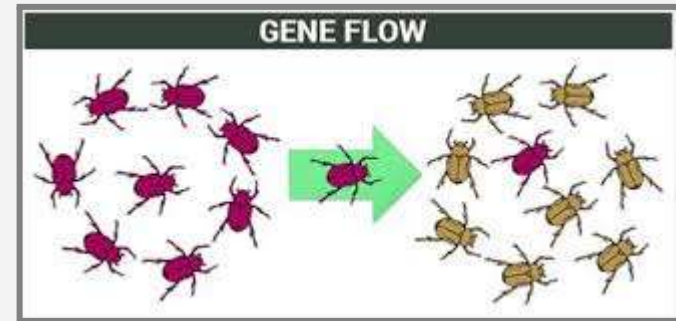
- **Directional Selection:** Favors **one extreme** trait.
 - **Example:** Giraffes with longer necks.
- **Disruptive Selection:** Favors **both extreme** traits but not the average.
 - **Example:** Birds with very small or very large beaks.
- **Stabilizing Selection:** Favors **average** traits and removes extremes.
 - **Example:** Human baby birth weights.



V. Mechanisms That Drive Evolution

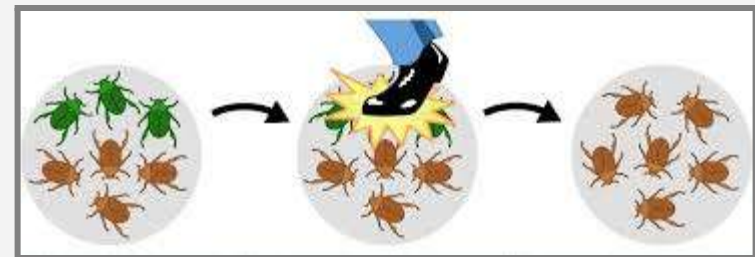
A. Gene Flow

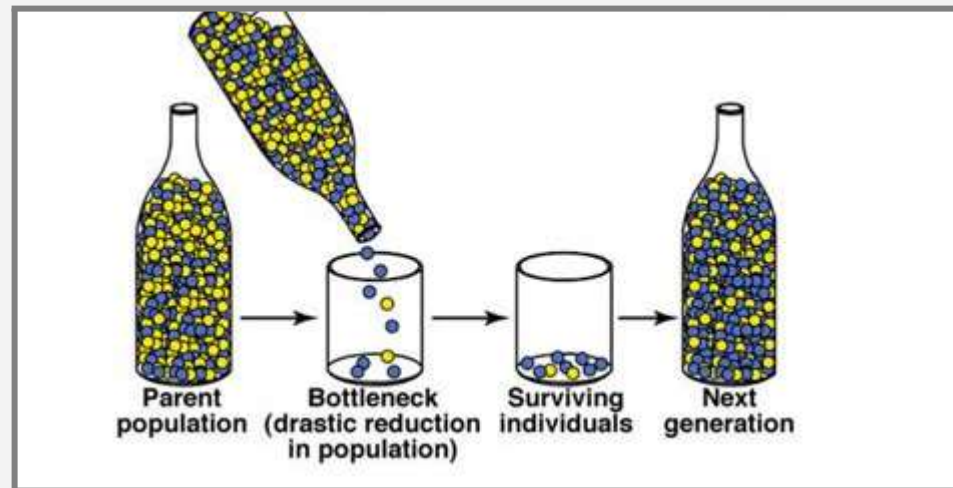
- **Movement of genes** between populations (e.g., animals migrating and breeding in new areas).



B. Genetic Drift

- **Random changes** in traits, especially in small populations. The **disappearance of genes** from a population
 - **Bottleneck Effect:** Population **shrinks**, **losing** genetic **diversity** (e.g., cheetahs).

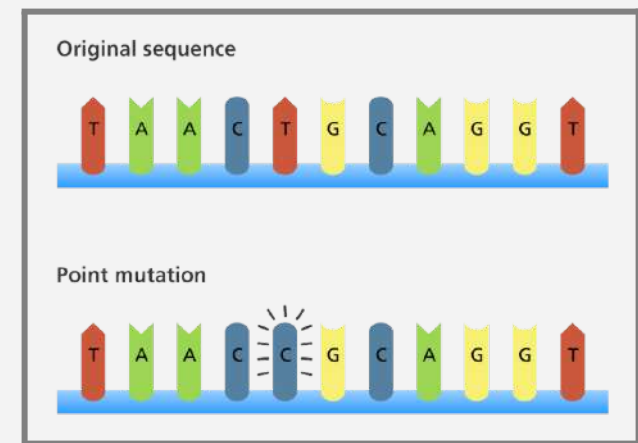




- **Founder Effect:** A small group starts a **new** population with **limited** traits.

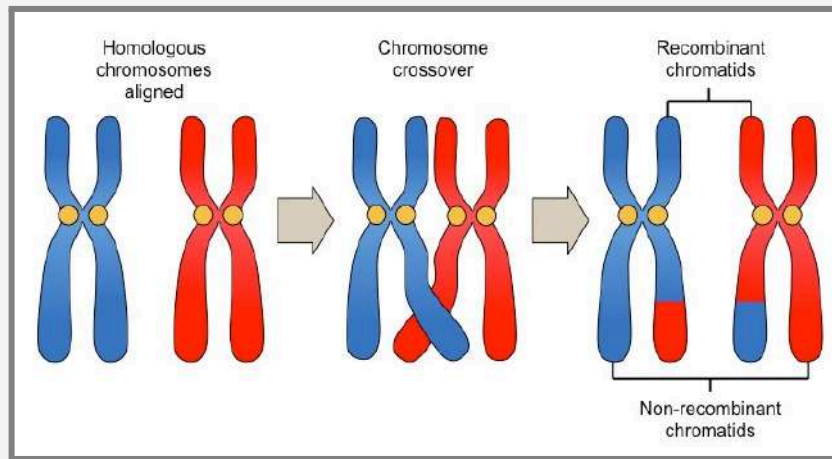
C. Mutations

- Changes in DNA introduce new traits.
 - **Example:** A **mutation** in fur color can help animals blend into their environment.



D. Genetic Recombination

- **Mixing of genes** during reproduction creates new trait combinations.
 - **Example:** Crossing Over during prophase I in Meiosis



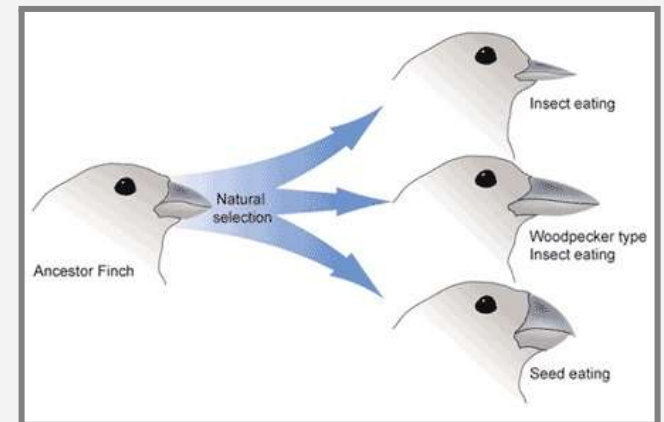
VI. Speciation

A. Definition

- The **formation** of new **species** when **populations** become **isolated** and stop interbreeding.

B. Causes

- **Geographic Isolation:** Physical barriers, like mountains or rivers.
- **Behavioral Isolation:** Differences in **mating** behaviors.
- **Temporal Isolation:** Reproducing at different **times**.



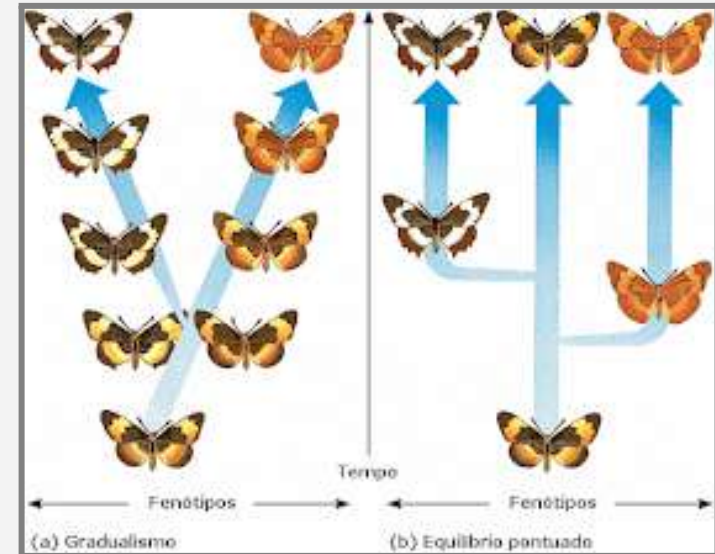
VII. Rates of Evolution

A. Gradualism

- Evolution happens **slowly** over a long time.
 - Fossil evidence shows continuous, small changes.

B. Punctuated Equilibrium

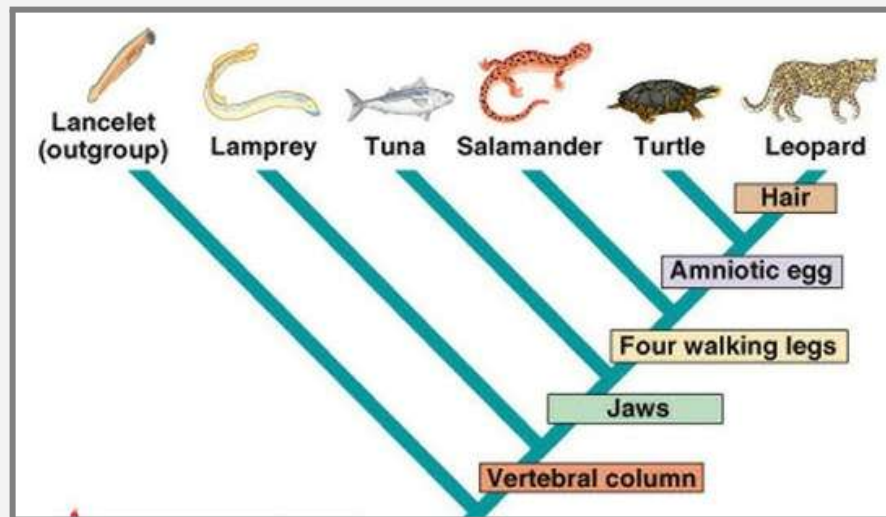
- Evolution happens in **bursts** with **long periods** of no **change** (stasis).
 - Triggered by sudden environmental changes or mutations.



VIII. Cladograms and Phylogenetic Trees

A. Definitions

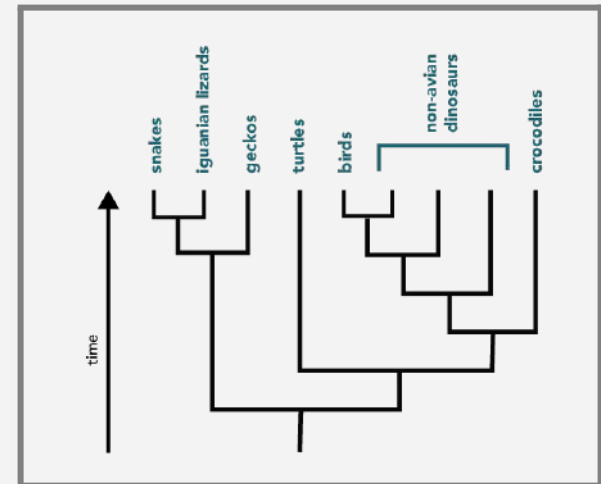
- **Cladogram:** Shows **relationships** based on **shared** traits.



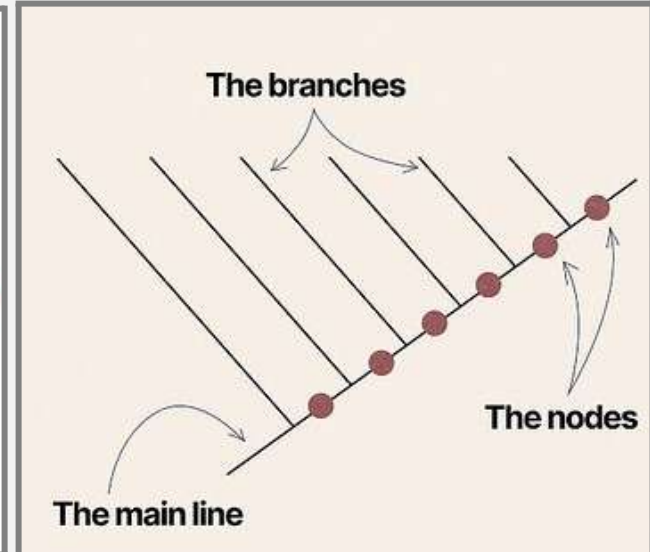
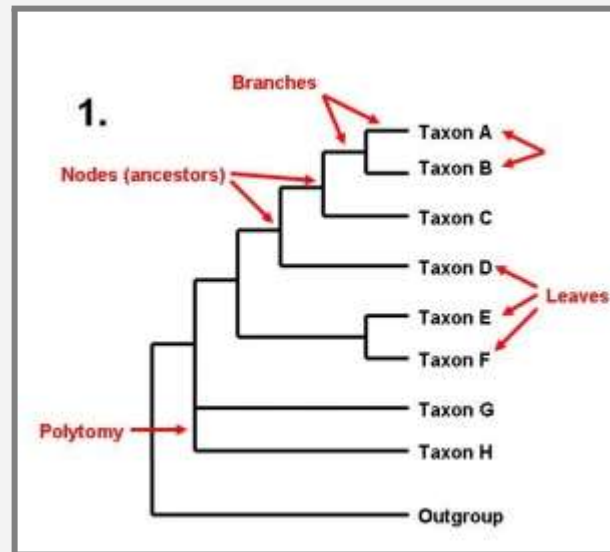
- **Phylogenetic Tree:** Shows **evolutionary relationships**, often with **time** included.

B. How to Read

- **Nodes:** Represent **common ancestors**.
- **Branches:** Show **evolutionary paths**.
- **Example:**
 - Species closer on the tree share a more recent ancestor.
 - Longer branches indicate more evolutionary change or time.



C. Example Diagram



IX. Environmental Changes and Evolution

A. Population Changes

- Favorable conditions lead to population growth.
- Unfavorable conditions can lead to extinction.

B. Speciation

- New species form when environments change and populations adapt.

C. Extinction

	<ul style="list-style-type: none"> • Rapid changes, like habitat destruction, can eliminate species unable to adapt.
<p>Notes Summary</p>	<p>Life on Earth is constantly changing through processes that shape species over time. Evolution explains how living organisms are connected through common ancestry, with evidence found in fossils, geographical distribution, and similarities in structures, DNA, and development. Traits that help organisms survive and reproduce, called adaptations, play a key role in natural selection, where favorable traits become more common in populations. Changes can happen gradually or in sudden bursts, leading to the formation of new species. Life's origins are linked to early chemical processes and the development of complex cells through cooperation between simpler ones. Understanding evolutionary relationships helps explain how species are connected and adapt to changing environments.</p>