



EVOLUTION

EVOLUTION

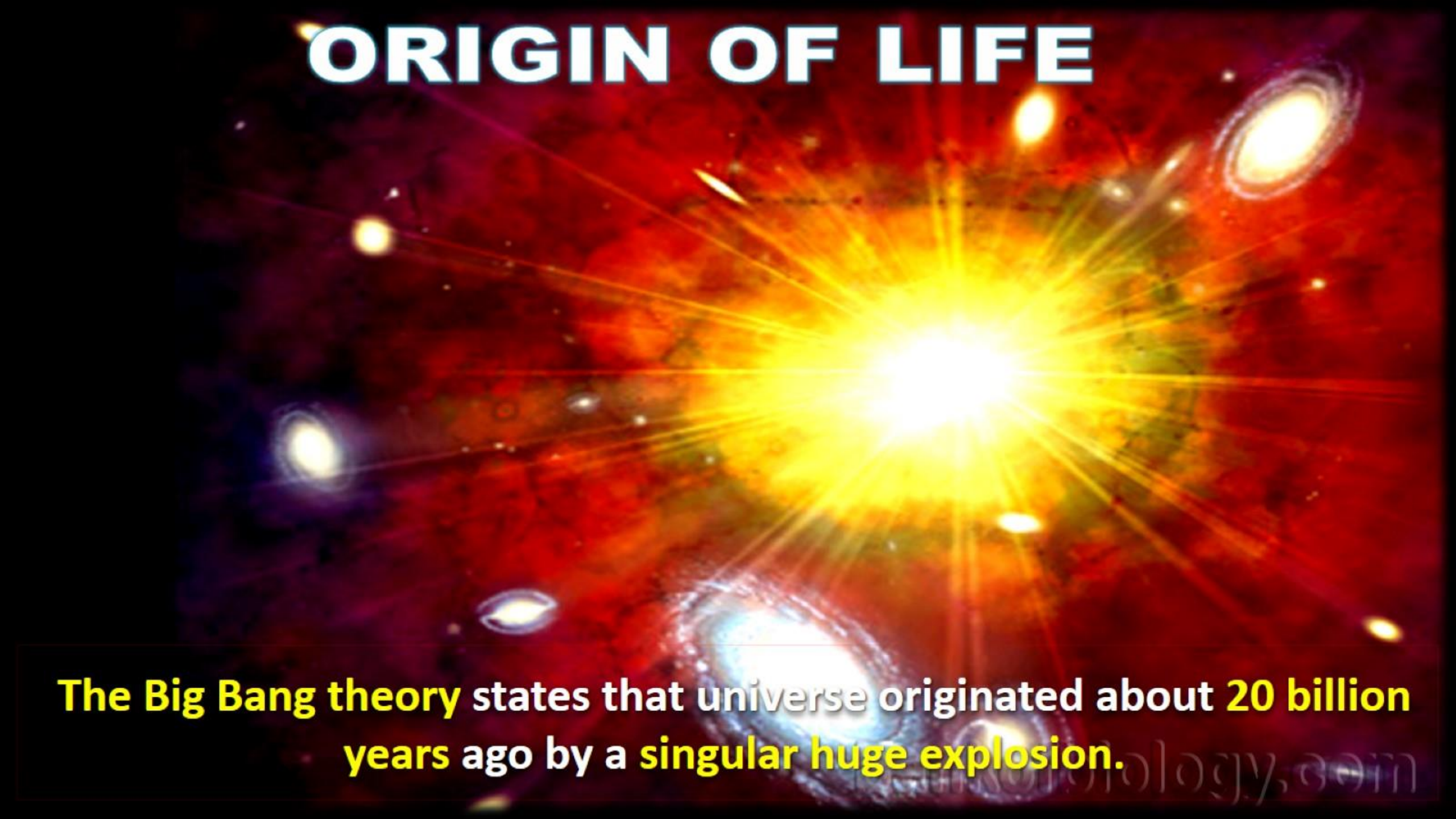


- ▶ **Evolution** is an orderly change from one form to another.
- ▶ **Evolutionary Biology** is the study of history of life forms on earth.



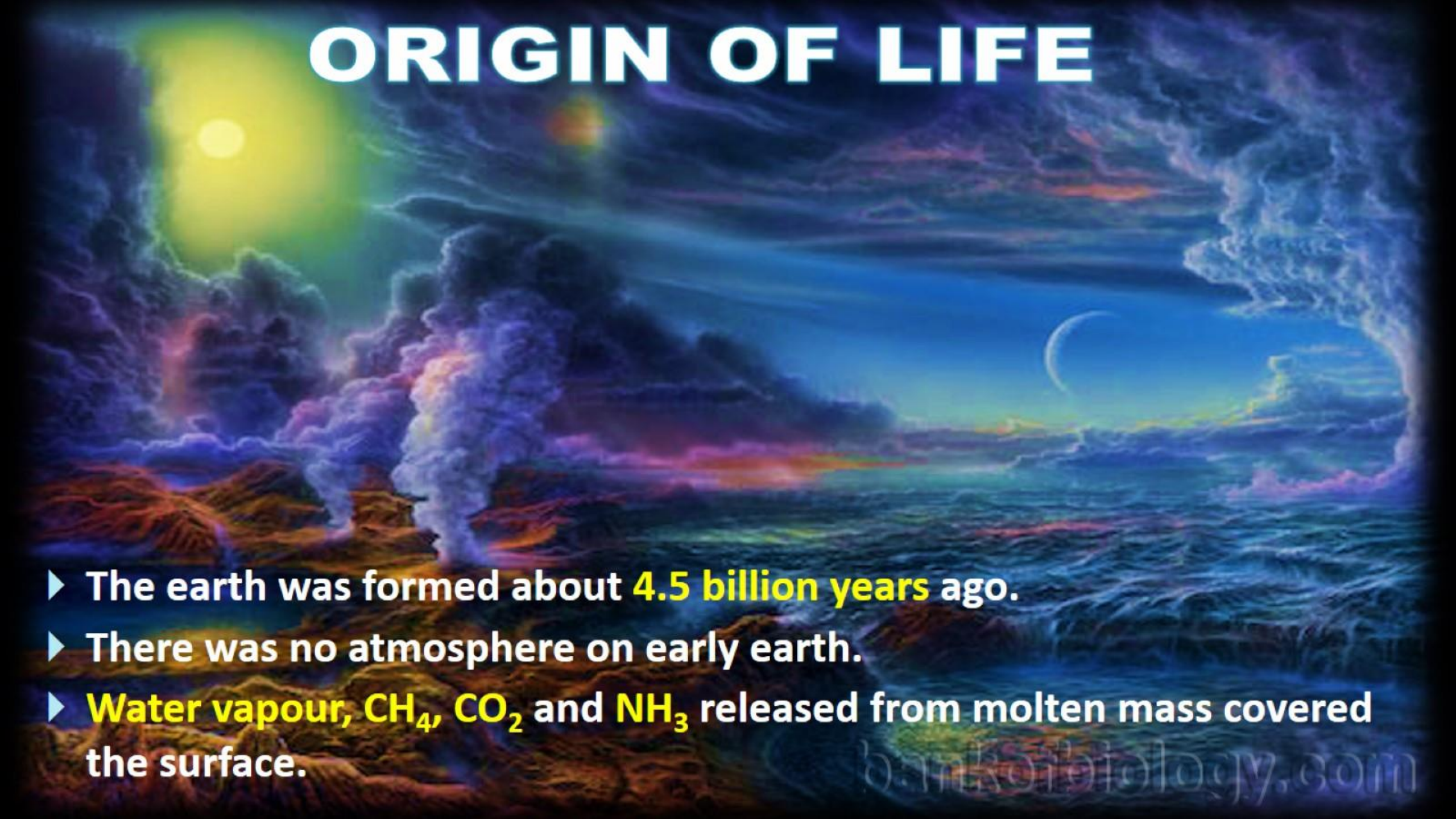
ORIGIN OF LIFE

ORIGIN OF LIFE



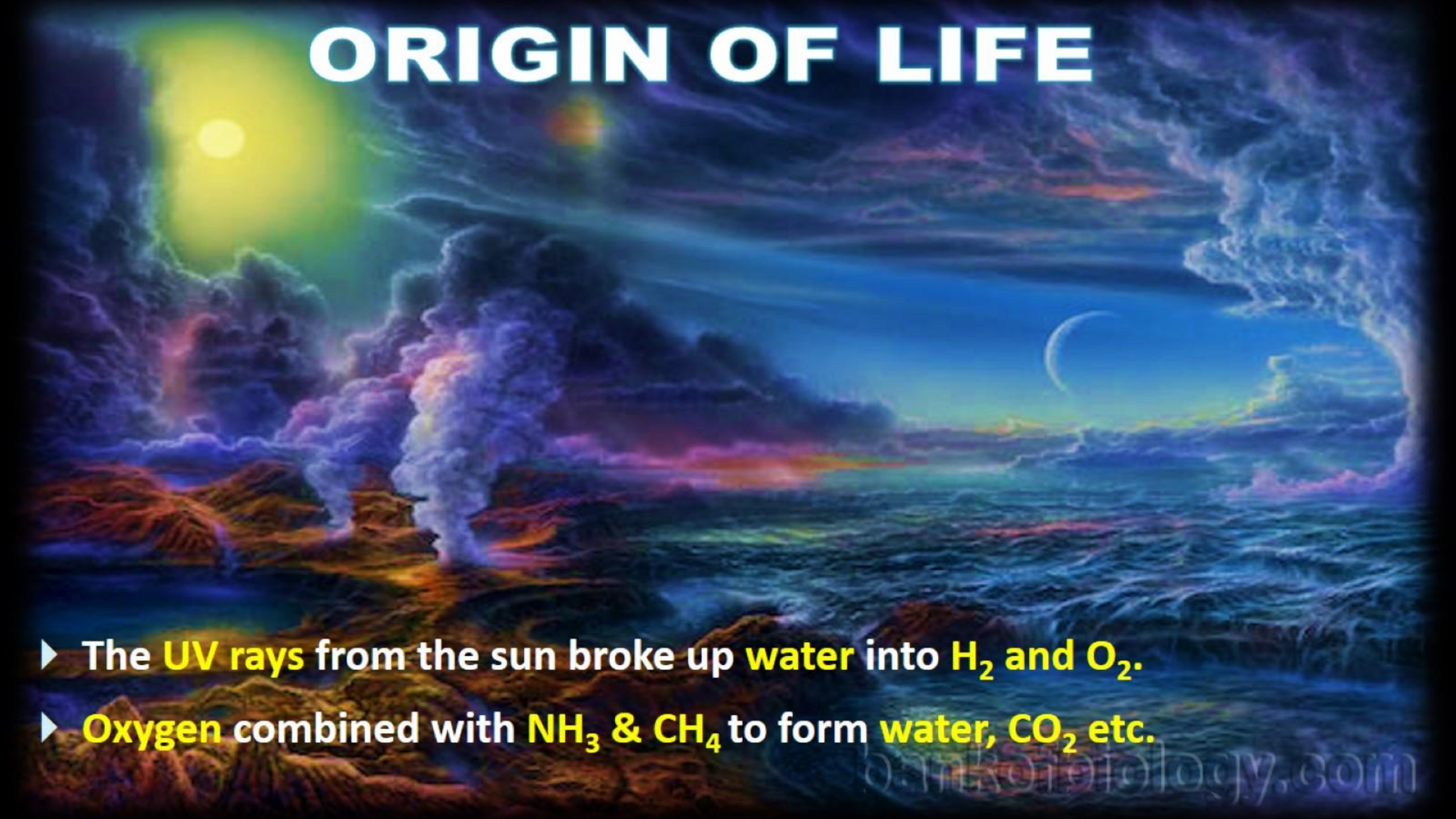
The Big Bang theory states that universe originated about **20 billion years** ago by a **singular huge explosion.**

ORIGIN OF LIFE

A dramatic illustration of early Earth. In the foreground, dark, jagged volcanic rocks are being consumed by two large, billowing plumes of white and grey smoke or ash that rise into the sky. The sky is a deep, dark blue, filled with wispy, ethereal clouds. A bright, glowing yellow sun is positioned in the upper left corner, casting a strong light. In the upper right, a thin, white crescent moon is visible against the dark sky. The overall atmosphere is one of intense heat and primordial activity.

- ▶ The earth was formed about **4.5 billion years** ago.
- ▶ There was no atmosphere on early earth.
- ▶ **Water vapour, CH₄, CO₂ and NH₃** released from molten mass covered the surface.

ORIGIN OF LIFE



- ▶ The **UV rays** from the sun broke up **water** into **H₂** and **O₂**.
- ▶ **Oxygen** combined with **NH₃** & **CH₄** to form **water, CO₂** etc.

ORIGIN OF LIFE



- ▶ The **ozone layer** was formed.
- ▶ As it cooled, the water vapour fell as rain to form oceans.
- ▶ Life appeared almost **four billion years ago.**

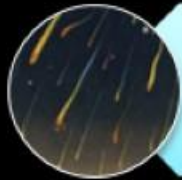
THEORIES OF ORIGIN OF LIFE



Theory of Abiogenesis



Theory of Biogenesis



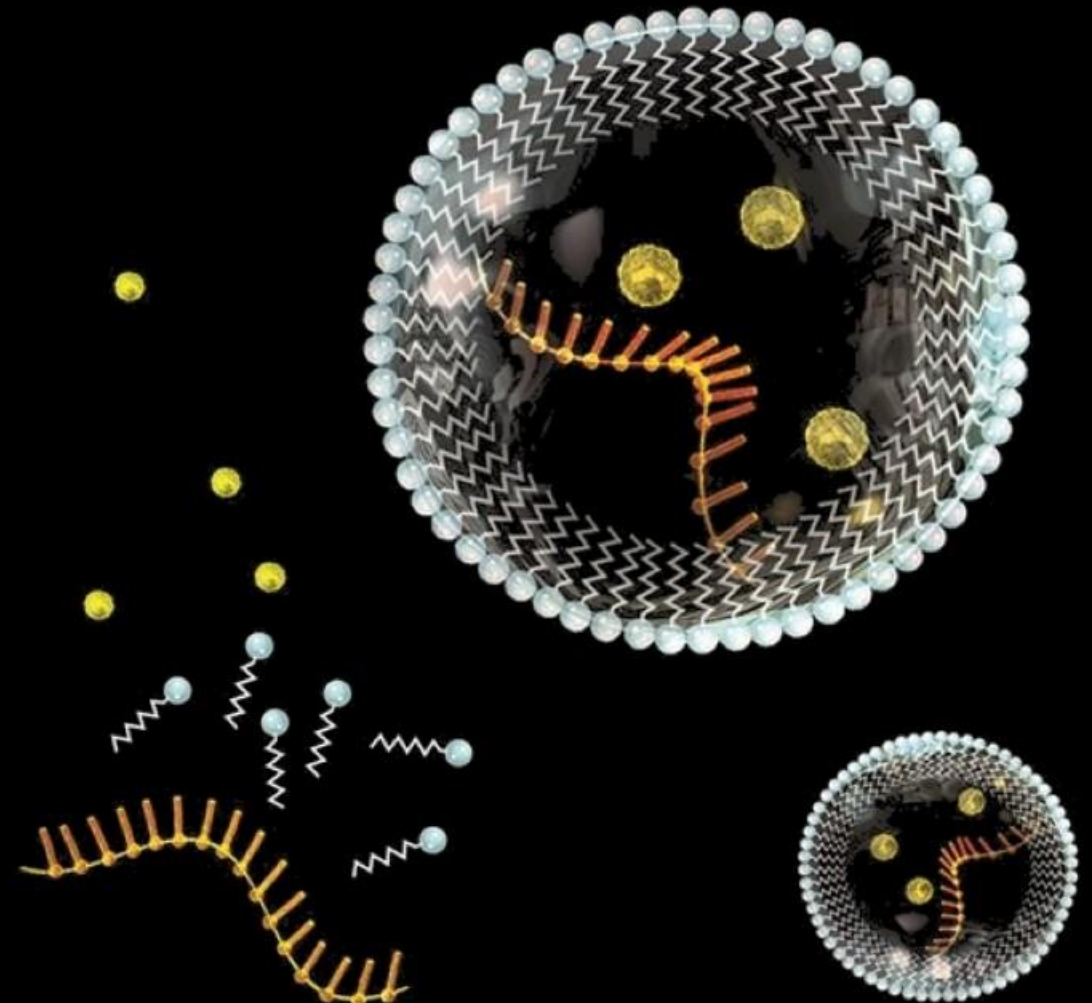
Theory of Panspermia



Theory of Creationism



Theory of Chemical evolution



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THEORIES OF ORIGIN OF LIFE

1. THEORY OF SPONTANEOUS GENERATION (ABIOTGENESIS)

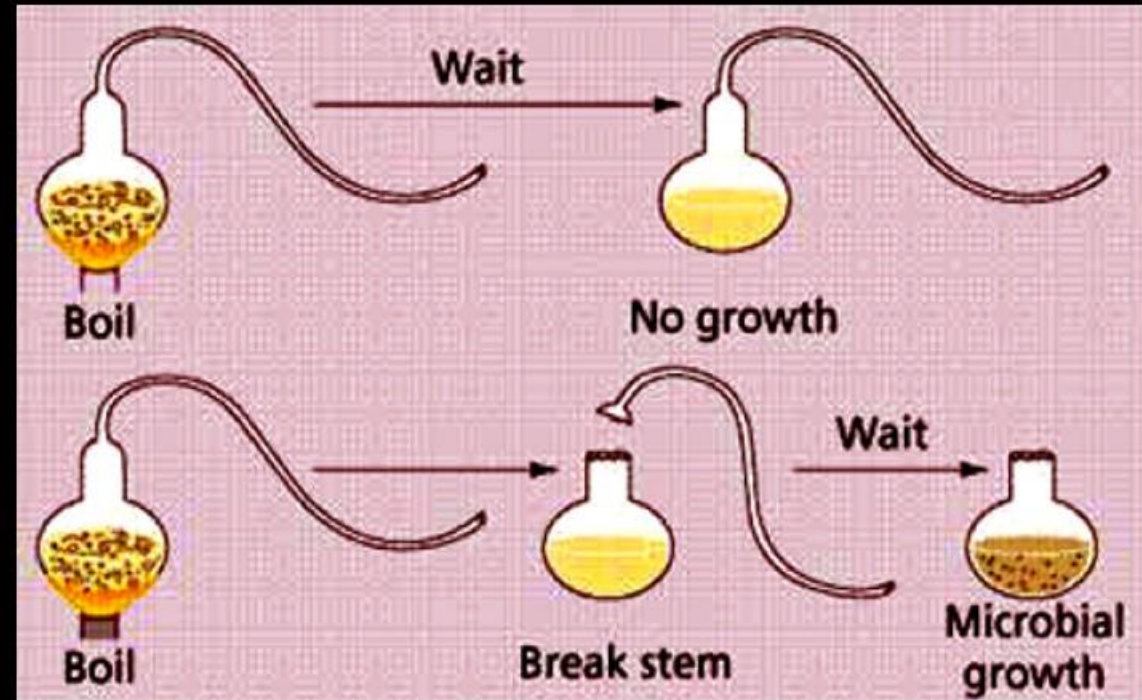


It states that, life came out of **decaying and rotting matter** like straw, mud etc.

THEORIES OF ORIGIN OF LIFE

1. THEORY OF SPONTANEOUS GENERATION (ABIOTGENESIS)

Louis Pasteur disproved
Abiogenesis theory.



- ▶ He demonstrated that **life comes only from pre-existing life**.
- ▶ He showed that life did not come from **killed yeast** in a closed pre-sterilized flask. But in an opened flask, life (microbes) appeared.

THEORIES OF ORIGIN OF LIFE

2. THEORY OF BIOGENESIS



- It is proposed by Francisco Redi, Spallanzani and Louis Pasteur.
- It states that, **life originates from pre-existing life.**
- But it does not explain origin of first life.



THEORIES OF ORIGIN OF LIFE

3. COSMIC THEORY (THEORY OF PANSPERMIA)

It states that, the **units of life (spores)** were transferred to different planets including earth.



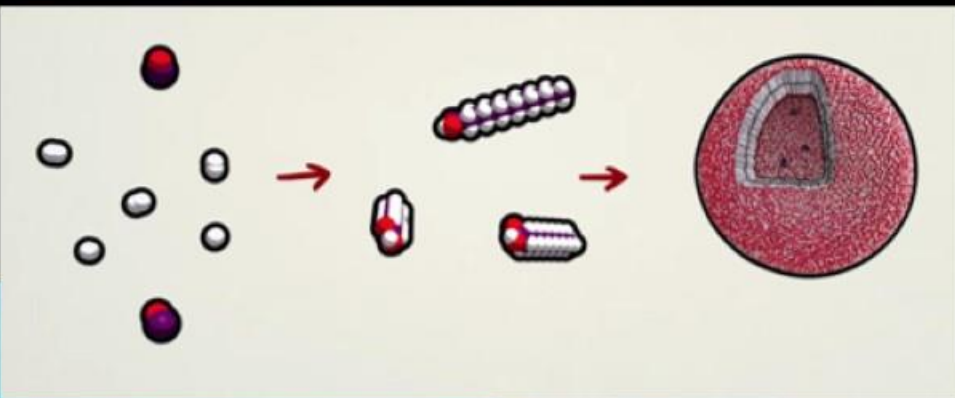
THEORIES OF ORIGIN OF LIFE

4. THEORY OF SPECIAL CREATION

It states that living and non-living was created by some **supernatural power (God)**.

THEORIES OF ORIGIN OF LIFE

5. THEORY OF CHEMICAL EVOLUTION



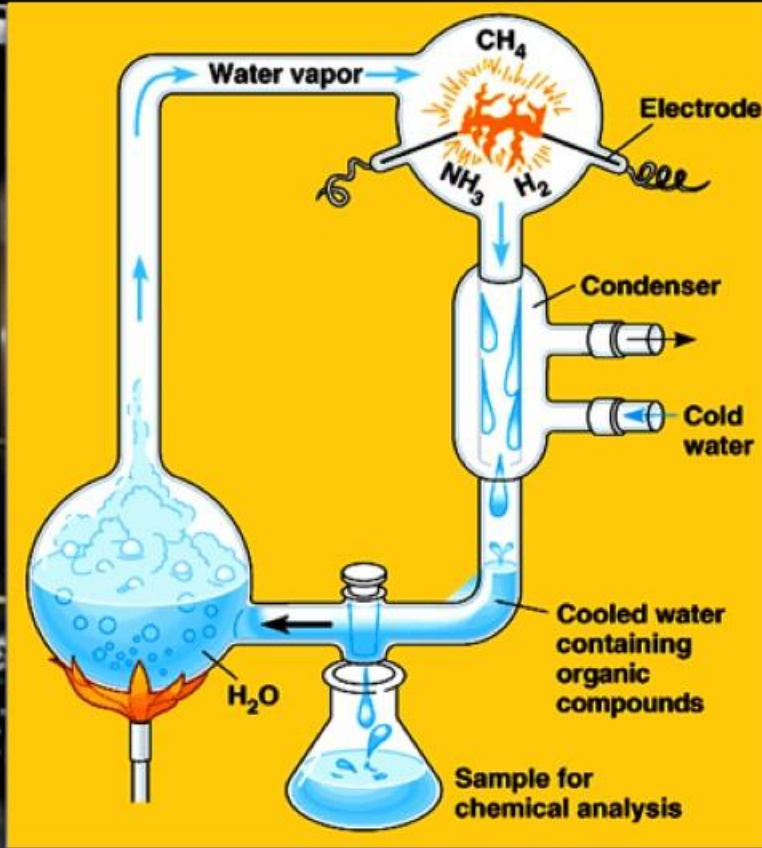
- ▶ Proposed by **Oparin & Haldane**.
- ▶ It states that, the first form of life was originated from non-living inorganic and organic molecules such as **CH₄, NH₃, H₂O, sugars, proteins, nucleic acids** etc.
- ▶ i.e. ***“Abiogenesis first, but biogenesis ever since”***.

THEORIES OF ORIGIN OF LIFE

5. THEORY OF CHEMICAL EVOLUTION



Experimental setup of Urey & Miller

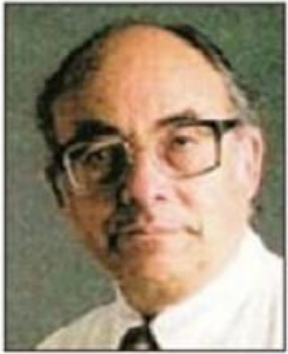


UREY-MILLER EXPERIMENT

- ▶ **Harold Urey** and **Stanley Miller** experimentally proved theory of chemical evolution.
- ▶ They created a condition like that of primitive earth (i.e. high temperature, volcanic storms, reducing atmosphere with CH_4 , NH_3 , H_2O , H_2 etc).

THEORIES OF ORIGIN OF LIFE

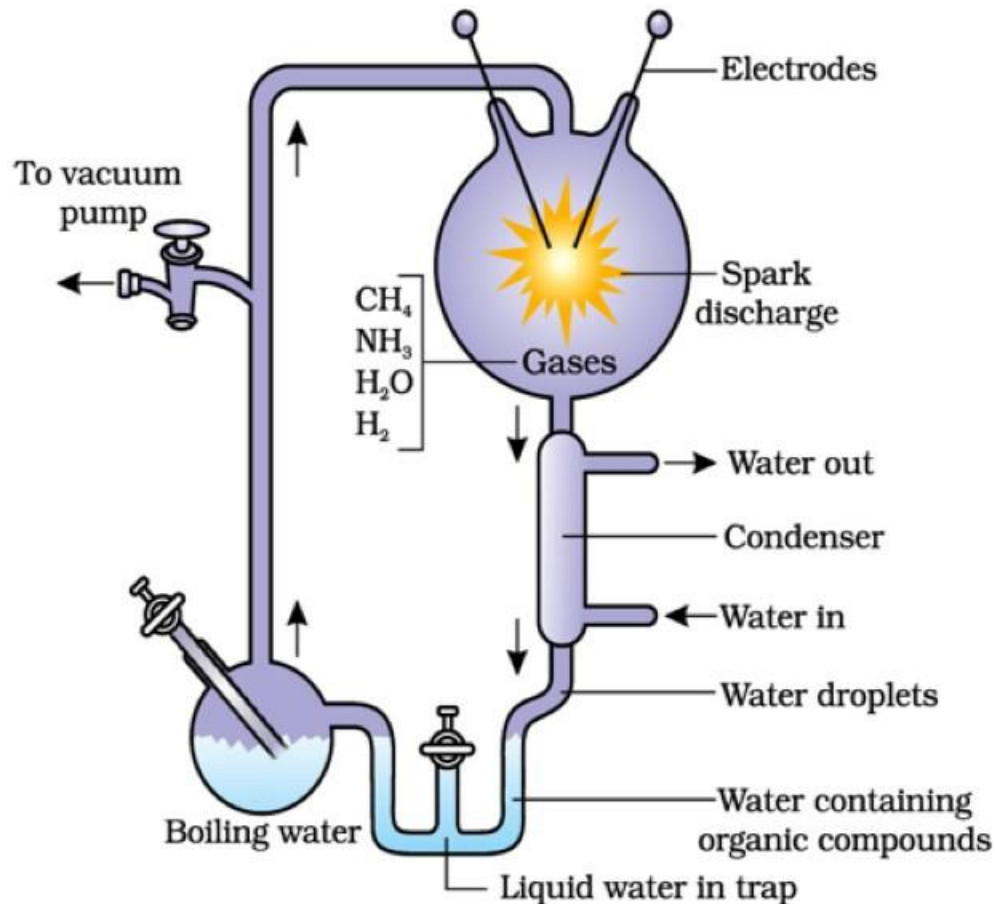
5. THEORY OF CHEMICAL EVOLUTION



Stanley L. Miller



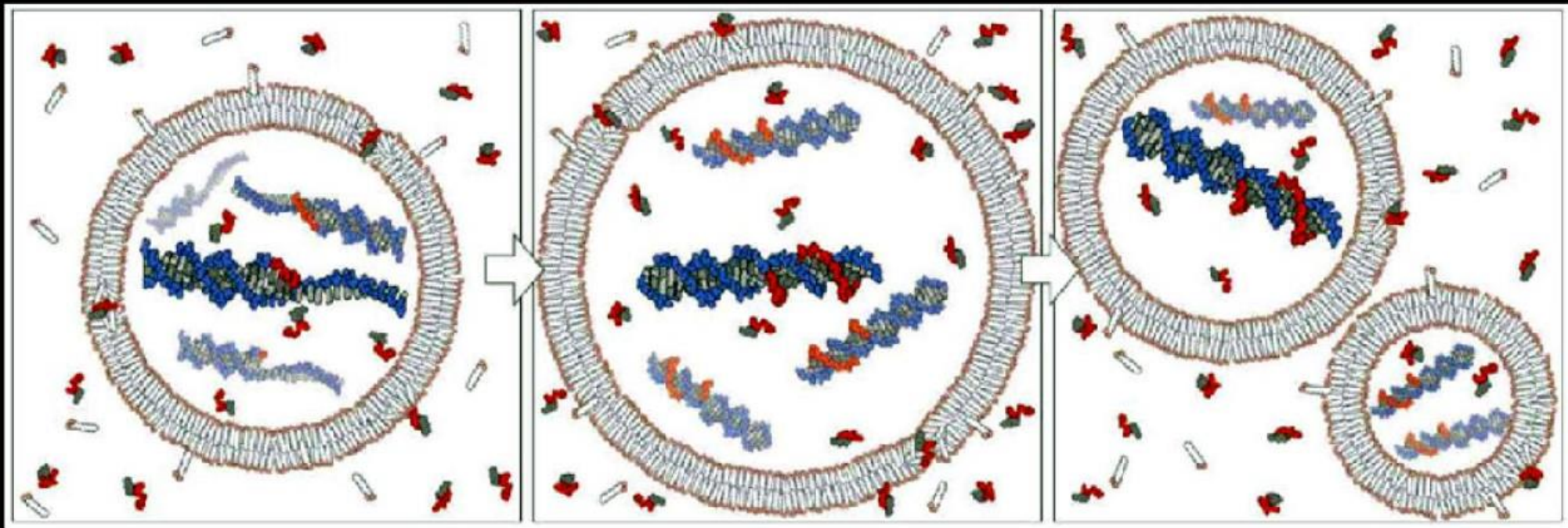
Harold C. Urey



UREY-MILLER EXPERIMENT

- ▶ They made electric discharge in a closed flask containing **CH₄, NH₃, H₂ and water vapour** at 800° C.
- ▶ As a result, some **amino acids** are formed.
- ▶ In similar experiments, others observed formation of sugars, nitrogen bases, pigment and fats.

THEORIES OF ORIGIN OF LIFE



- ▶ The first **non-cellular forms** of life originated **3 billion years ago**.
- ▶ They were **self replicating metabolic capsule** containing macromolecules like **RNA, proteins, Polysaccharides** etc.

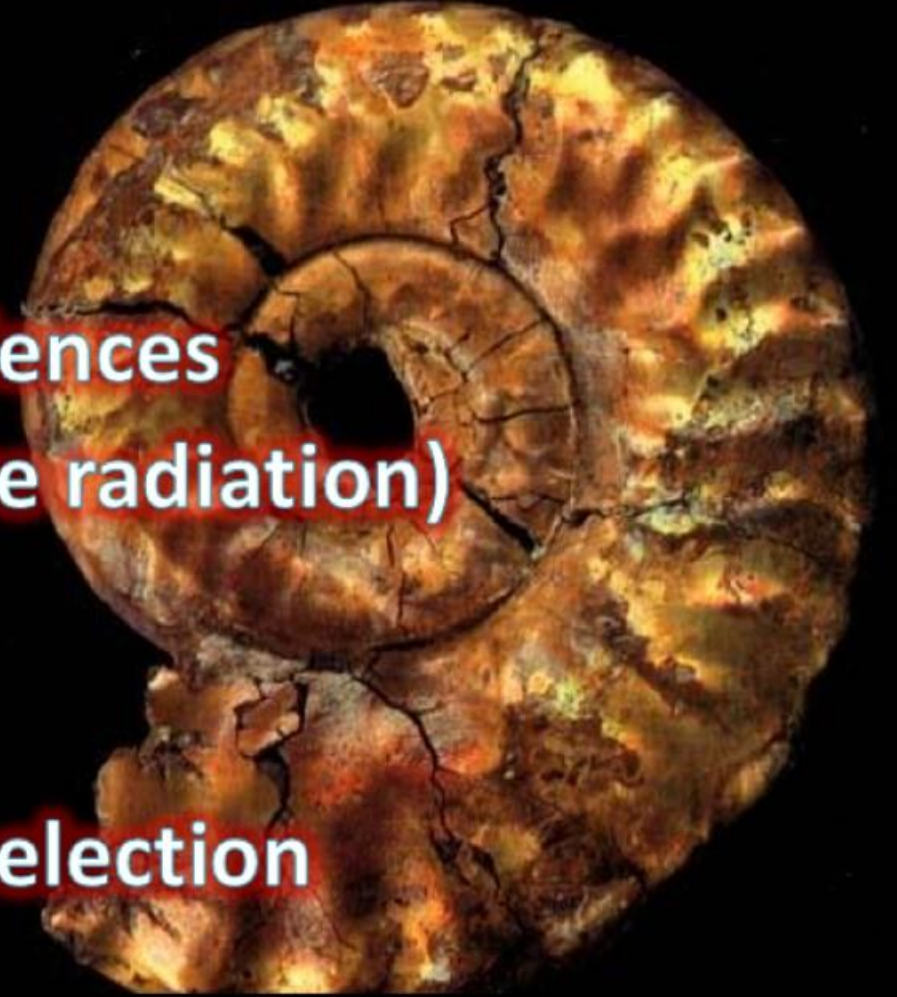
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EVIDENCES FOR EVOLUTION



EVIDENCES FOR EVOLUTION

- ▶ **Paleontological evidences**
- ▶ **Morphological and Anatomical evidences**
- ▶ **Biogeographical evidences (Adaptive radiation)**
- ▶ **Biochemical evidences**
- ▶ **Embryological evidences**
- ▶ **Evidences for evolution by natural selection**



EVIDENCES FOR EVOLUTION

1. PALAEOONTOLOGICAL EVIDENCES



- ▶ **Palaeontology** is the study of fossils.
- ▶ **Fossils** are remnants of life forms found in rocks (earth crust).
- ▶ ***Fossils are written documents of evolution.***



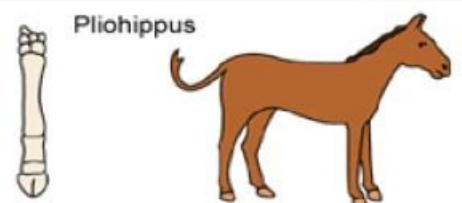
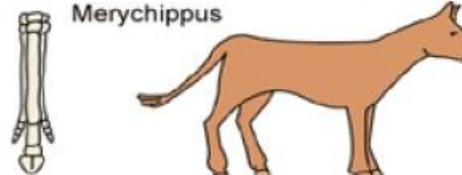
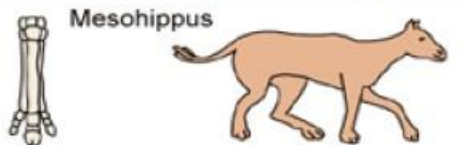
EVIDENCES FOR EVOLUTION

1. PALAEOONTOLOGICAL EVIDENCES

SIGNIFICANCE OF FOSSILS

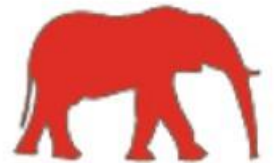
- ✓ To study **phylogeny (evolutionary history or race history)**. E.g. Horse evolution.

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1 million years ago	 modern horse Height: 1.6 m
10 million years ago	 Pliohippus Height: 1.0 m
30 million years ago	 Merychippus Height: 1.0 m
40 million years ago	 Mesohippus Height: 0.6 m
60 million years ago	 Eohippus Height: 0.4 m



African savannah elephant



Asian elephant



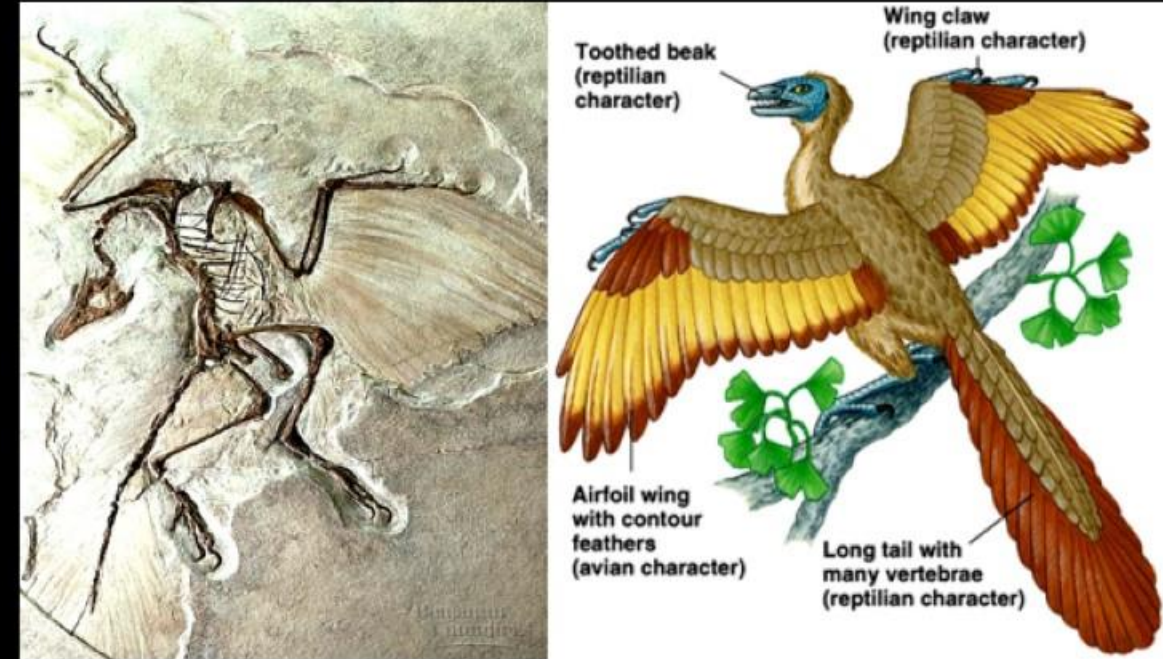
Woolly mammoth

EVIDENCES FOR EVOLUTION

1. PALAEOONTOLOGICAL EVIDENCES

SIGNIFICANCE OF FOSSILS

- ✓ To study **phylogeny (evolutionary history or race history)**. E.g. Horse evolution.
- ✓ To study the **connecting link** between two groups of organisms. E.g. *Archaeopteryx*.



Archaeopteryx:

Connecting link between reptiles and birds

EVIDENCES FOR EVOLUTION

1. PALAEOONTOLOGICAL EVIDENCES

SIGNIFICANCE OF FOSSILS

- ✓ To study **phylogeny (evolutionary history or race history)**. E.g. Horse evolution.
- ✓ To study the **connecting link** between two groups of organisms. E.g. *Archaeopteryx*.
- ✓ To study about **extinct animals**. E.g. Dinosaurs.

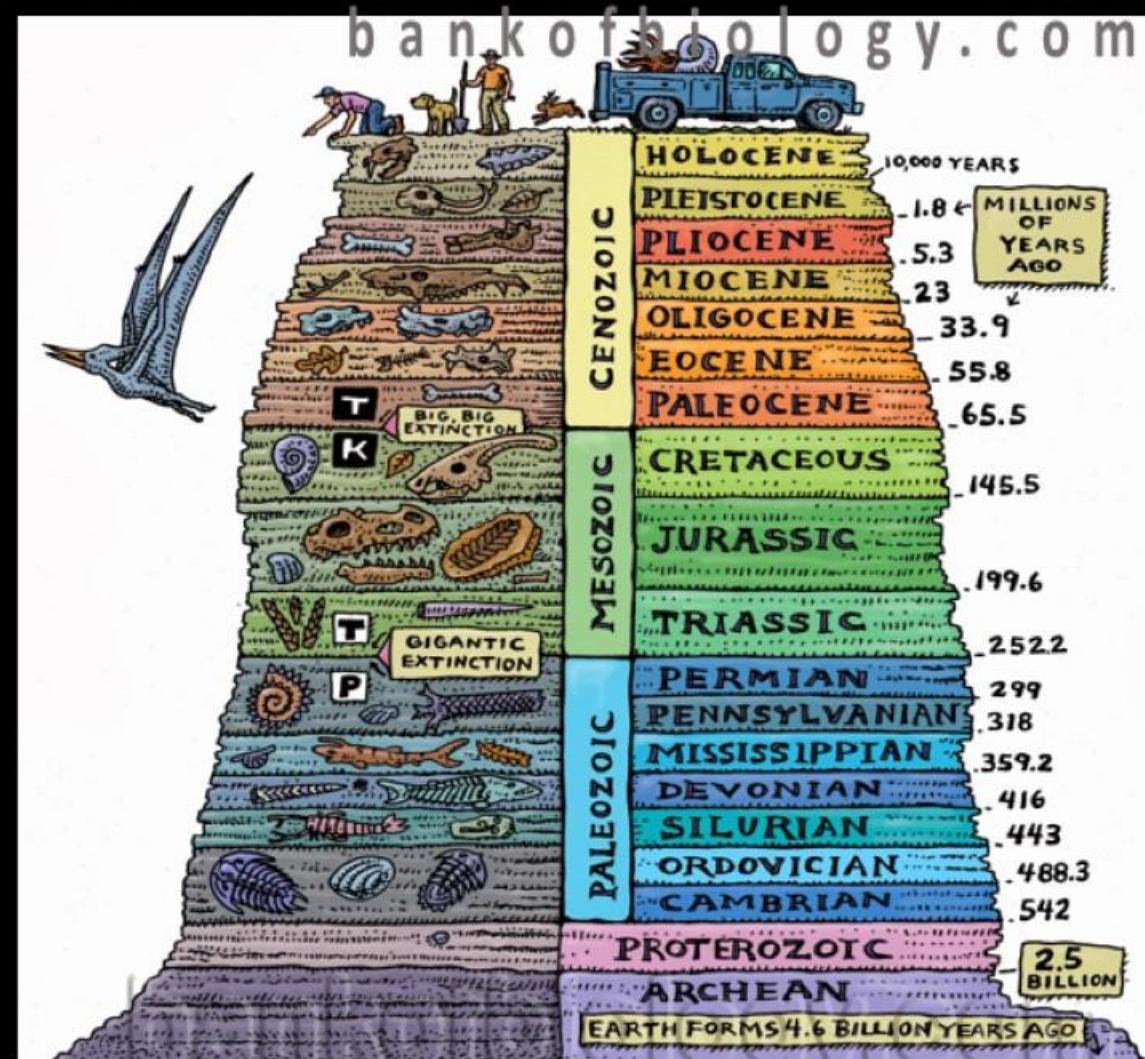


EVIDENCES FOR EVOLUTION

1. PALAEOONTOLOGICAL EVIDENCES

SIGNIFICANCE OF FOSSILS

- ✓ To study **phylogeny (evolutionary history or race history)**. E.g. Horse evolution.
- ✓ To study the **connecting link** between two groups of organisms. E.g. *Archaeopteryx*.
- ✓ To study about **extinct animals**. E.g. Dinosaurs.
- ✓ To study about **geological period** by analysing fossils in sedimentary rock layers. The study showed that life forms varied over time and certain life forms are restricted to certain geological time spans.



EVIDENCES FOR EVOLUTION

2. MORPHOLOGICAL & ANATOMICAL EVIDENCES

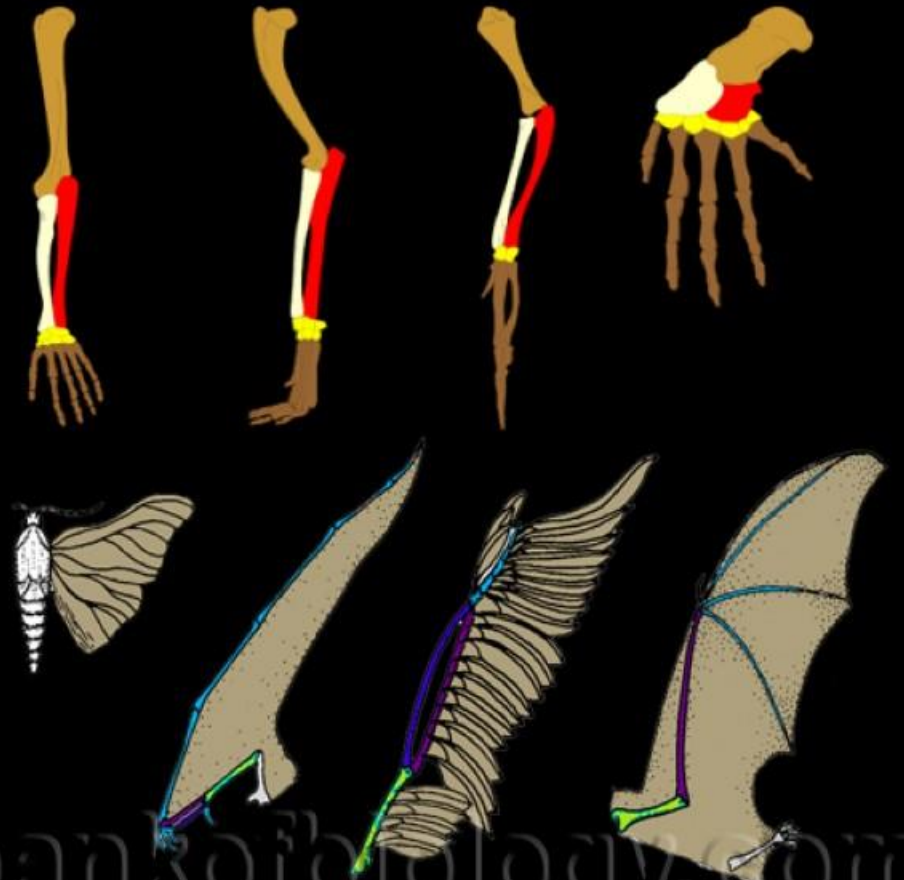
- **Comparative anatomy and morphology** shows that different forms of animals have some common structural features.
- This can be explained as follows:



Homologous organs & Homology



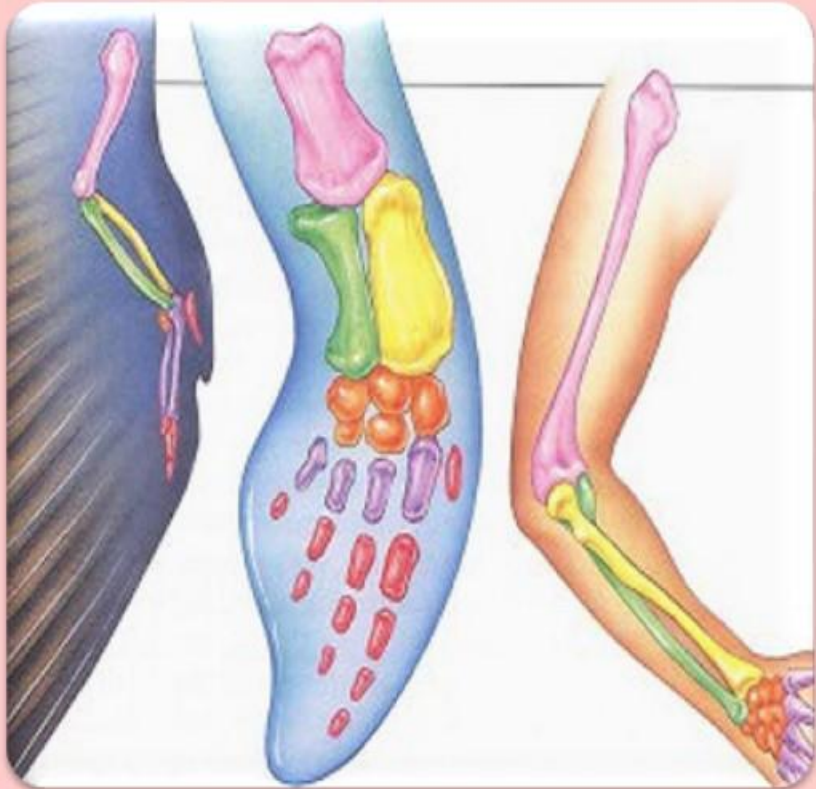
Analogous organs & Analogy



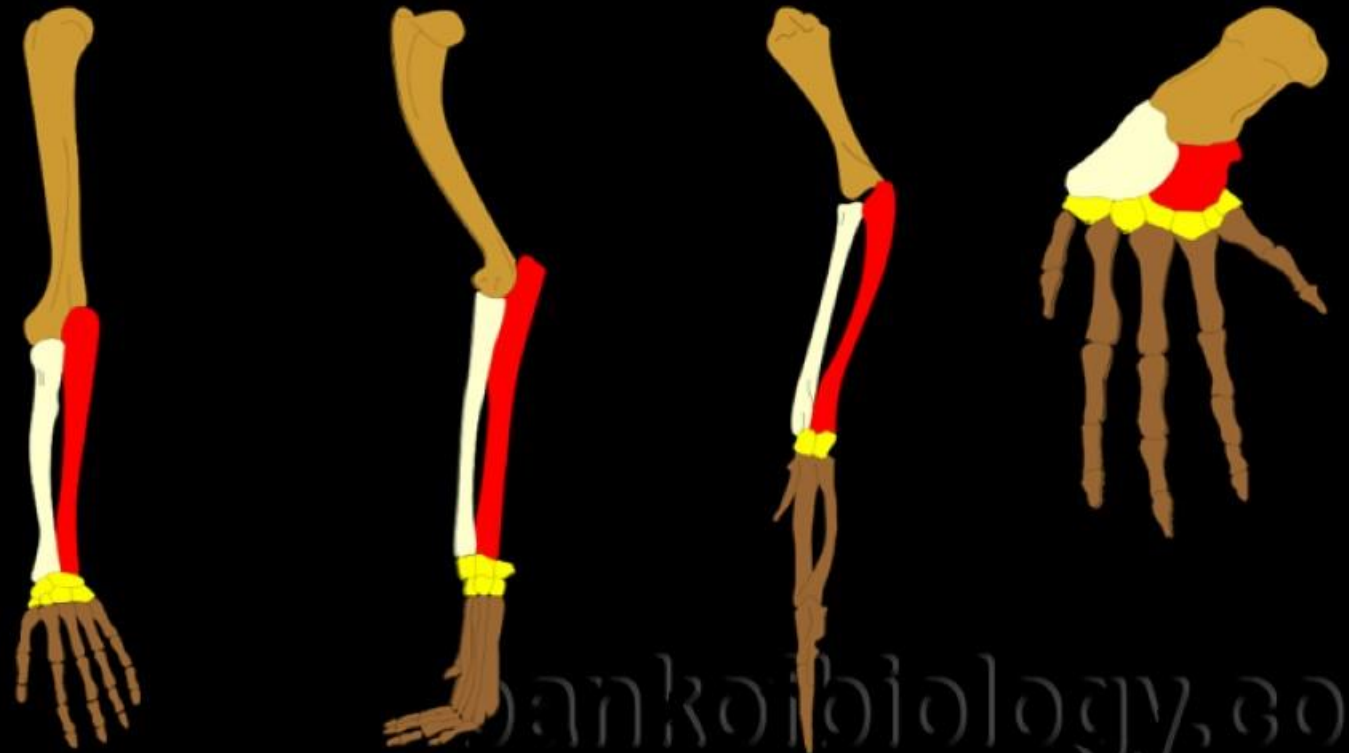
EVIDENCES FOR EVOLUTION

2. MORPHOLOGICAL & ANATOMICAL EVIDENCES

Homologous organs and Homology



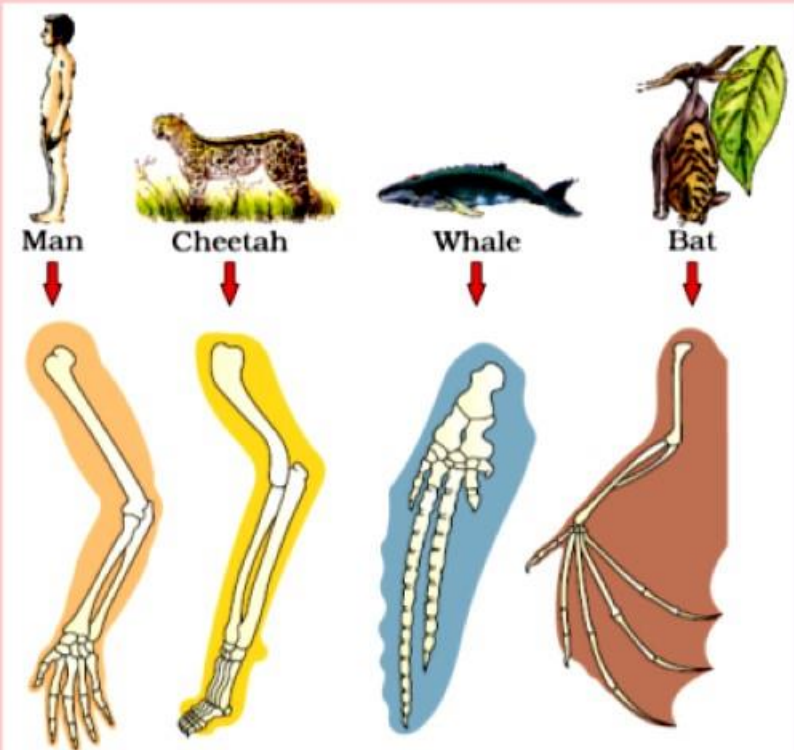
- **Homologous organs:** The organs having fundamental similarity in structure and origin but different functions. This phenomenon is called **Homology**.



EVIDENCES FOR EVOLUTION

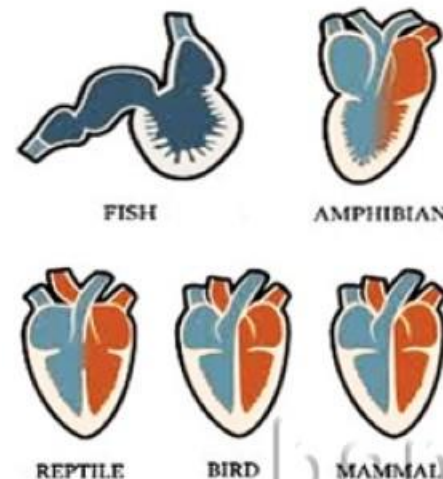
2. MORPHOLOGICAL & ANATOMICAL EVIDENCES

Homologous organs and Homology

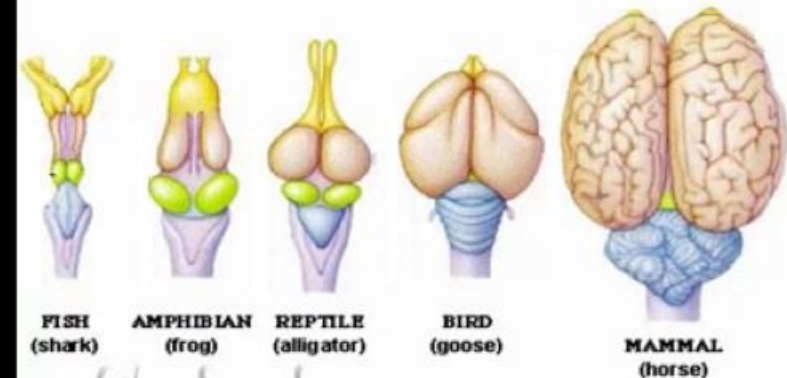


- E.g. **Human hand, Whale's flippers, Bat's wing & Cheetah's foot.** These forelimbs have different functions but similar anatomical structures such as bones (e.g. humerus, radius, ulna, carpals, metacarpals & phalanges).
- Homology is also seen in **heart, brain etc.**

Hearts of vertebrates



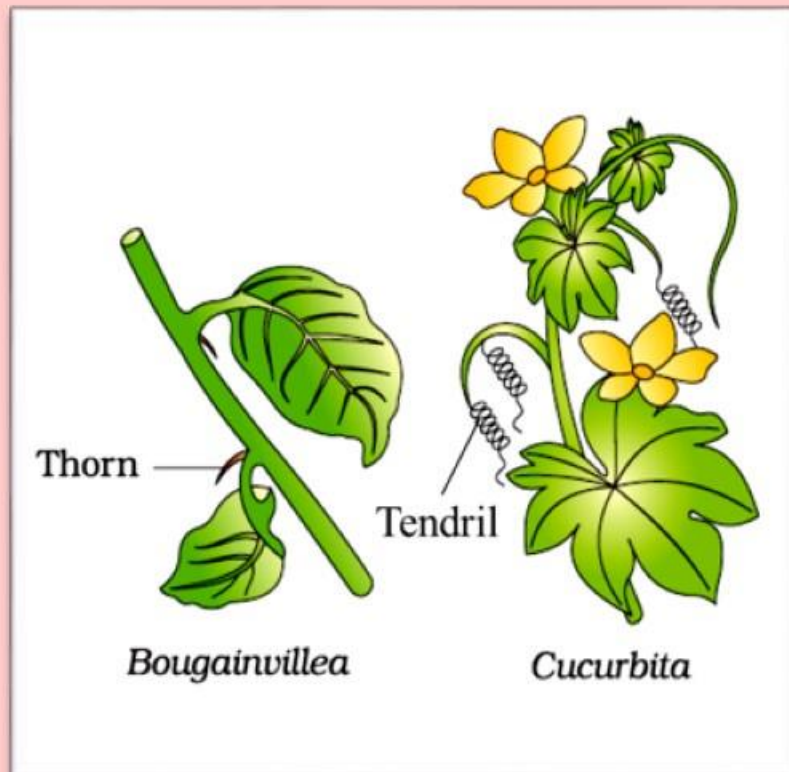
Brain of vertebrates



EVIDENCES FOR EVOLUTION

2. MORPHOLOGICAL & ANATOMICAL EVIDENCES

Homologous organs and Homology



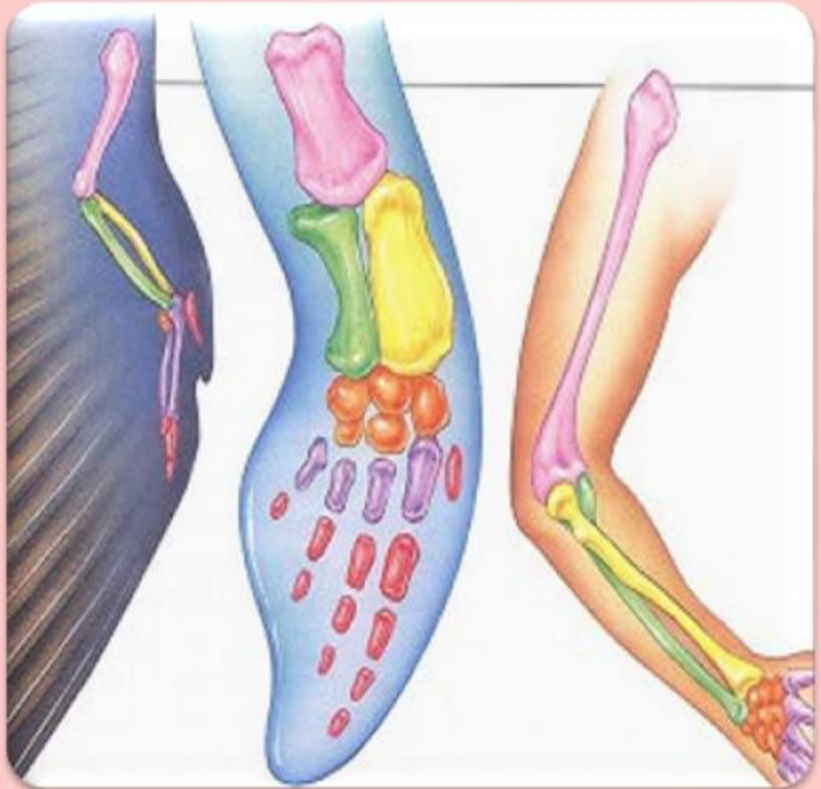
Homology in plants: Thorns and tendrils of *Bougainvillea* and *Cucurbita*.



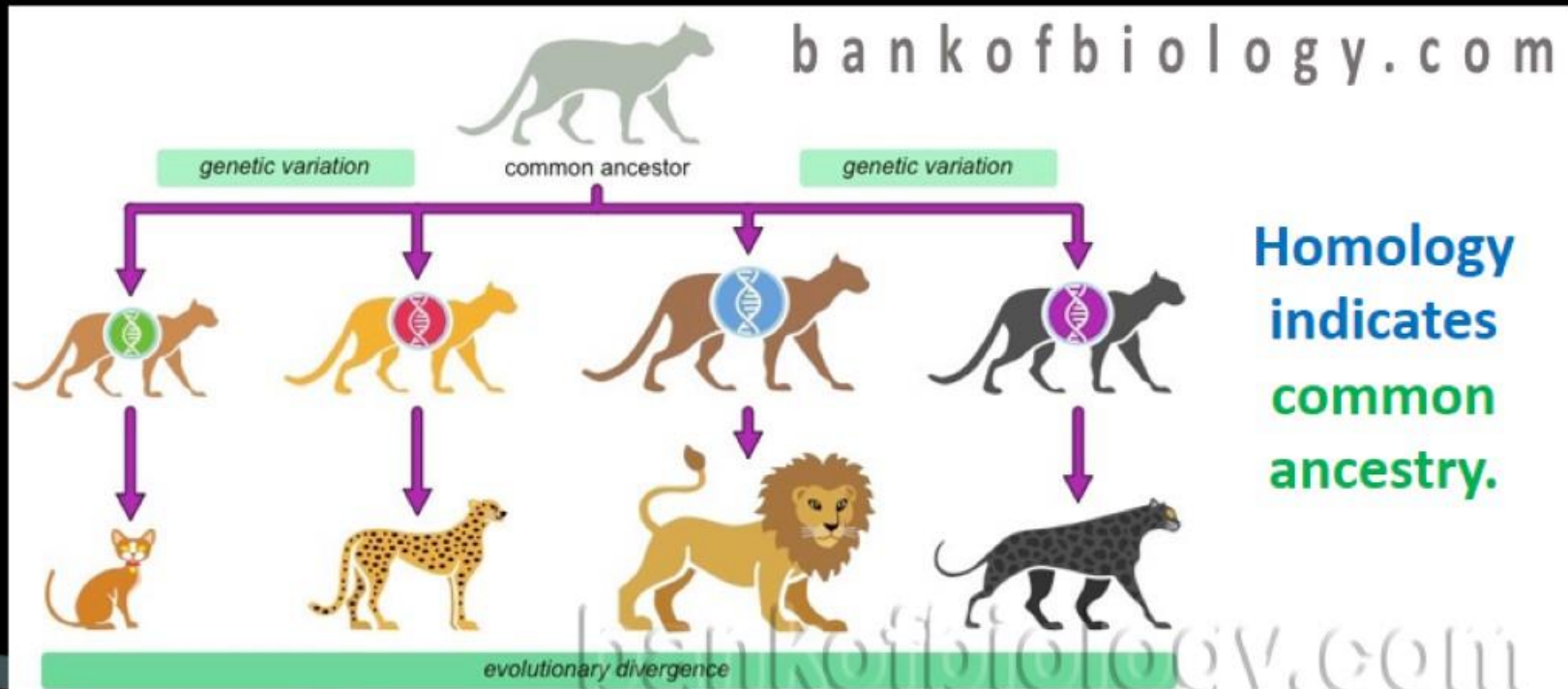
EVIDENCES FOR EVOLUTION

2. MORPHOLOGICAL & ANATOMICAL EVIDENCES

Homologous organs and Homology



- ▶ Origin of homologous organs is due to **Divergent evolution**.
- ▶ **Divergent evolution** is the evolution by which **related species** become **less similar** to survive and adapt in **different environmental** condition.

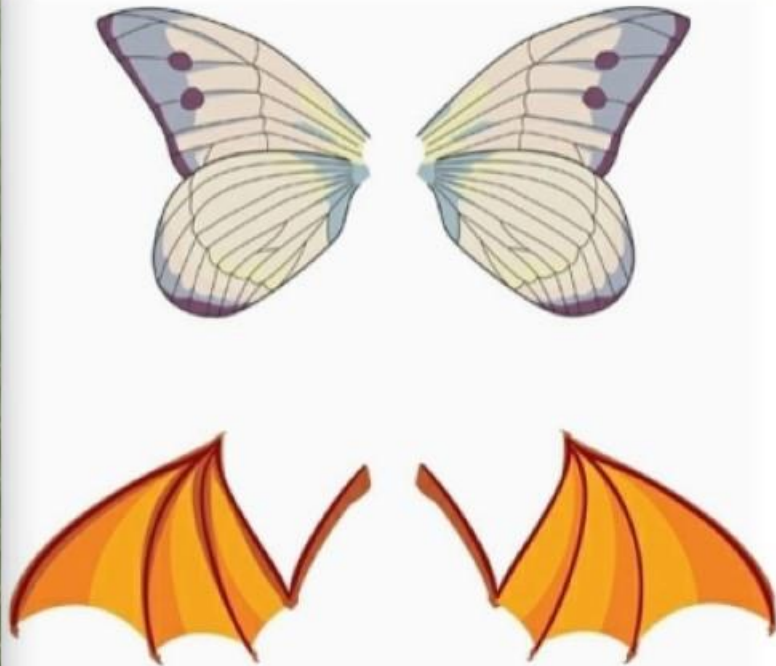


Homology
indicates
common
ancestry.

EVIDENCES FOR EVOLUTION

2. MORPHOLOGICAL & ANATOMICAL EVIDENCES

Analogous organs and Analogy



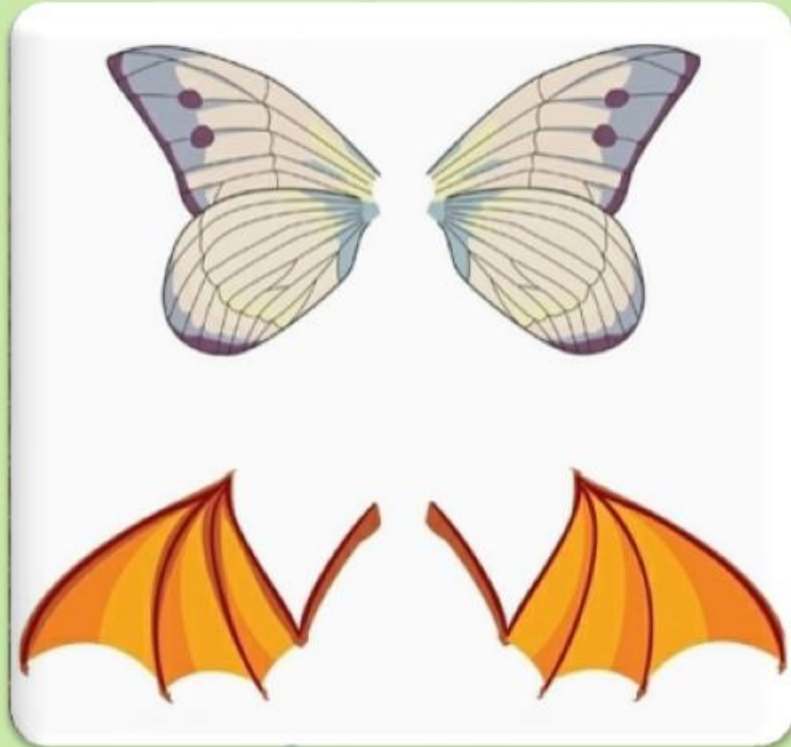
- ▶ **Analogous organs:** The organs having similar function but different structure and origin. This phenomenon is called **Analogy**.



EVIDENCES FOR EVOLUTION

2. MORPHOLOGICAL & ANATOMICAL EVIDENCES

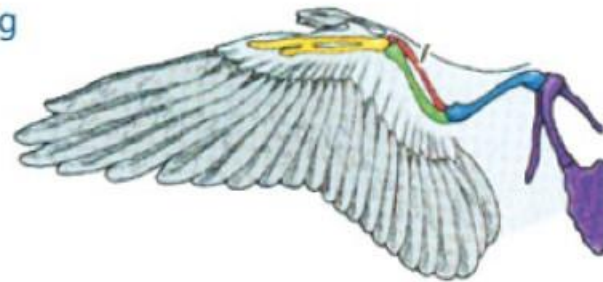
Analogous organs and Analogy



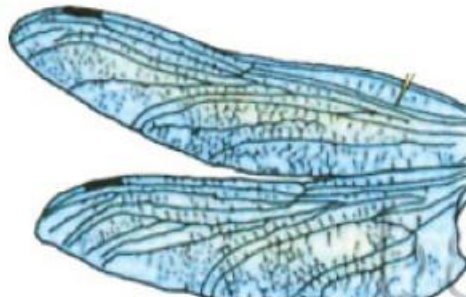
Examples

- **Wings of insects** (formed of a thin flap of chitin) and **wings of birds** (modified forelimbs).

Bird wing



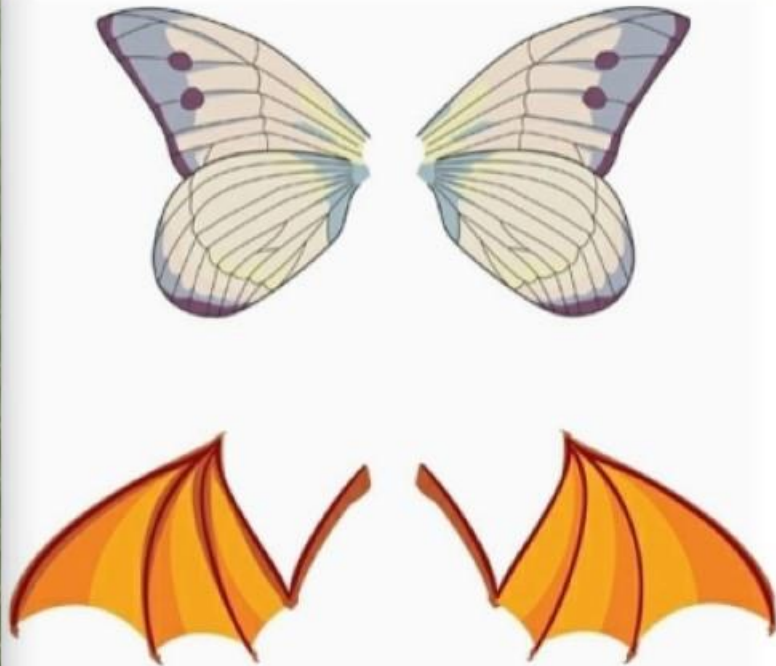
Insect wing



EVIDENCES FOR EVOLUTION

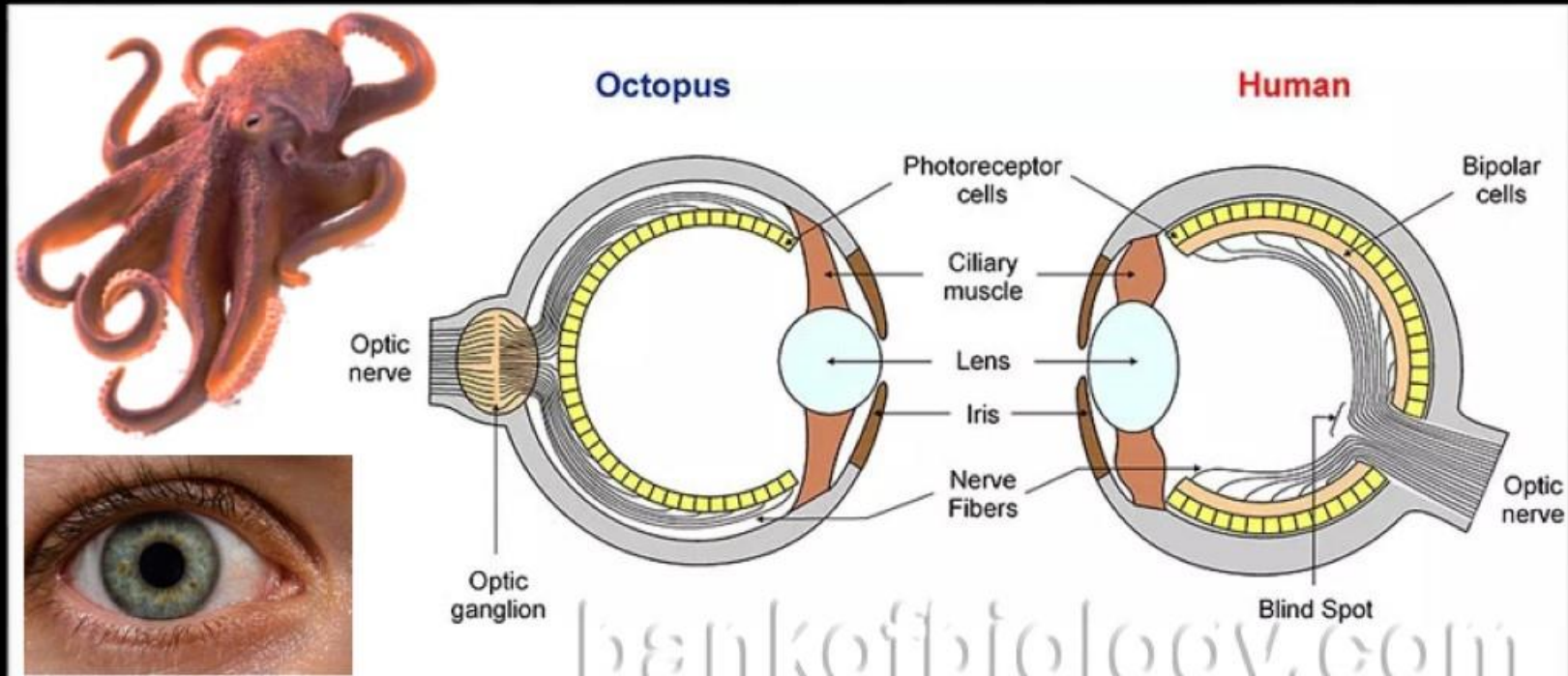
2. MORPHOLOGICAL & ANATOMICAL EVIDENCES

Analogous organs and Analogy



Examples

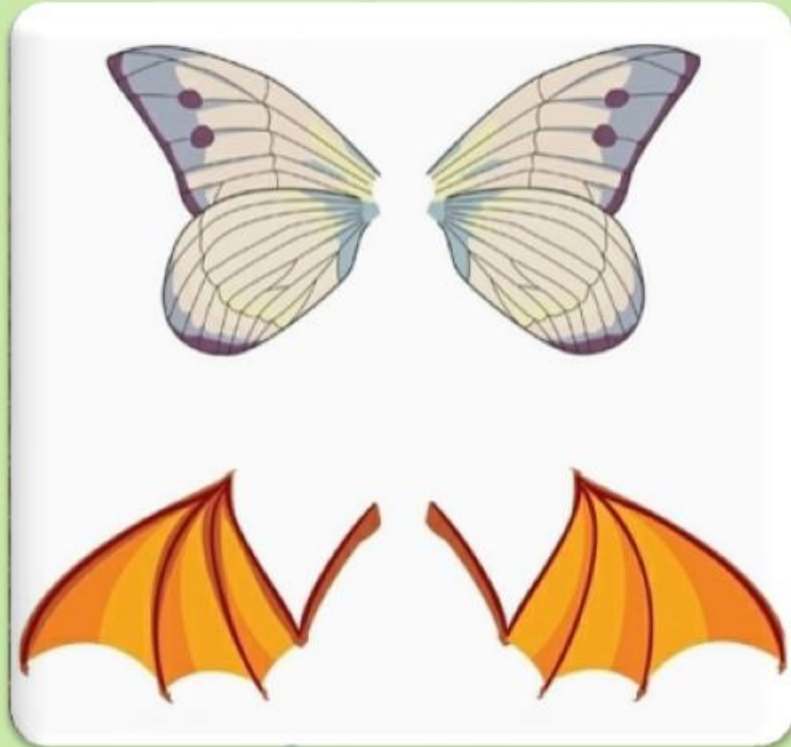
- **Eyes of Octopus** (retina from skin) and **mammals** (retina from embryonic brain).



EVIDENCES FOR EVOLUTION

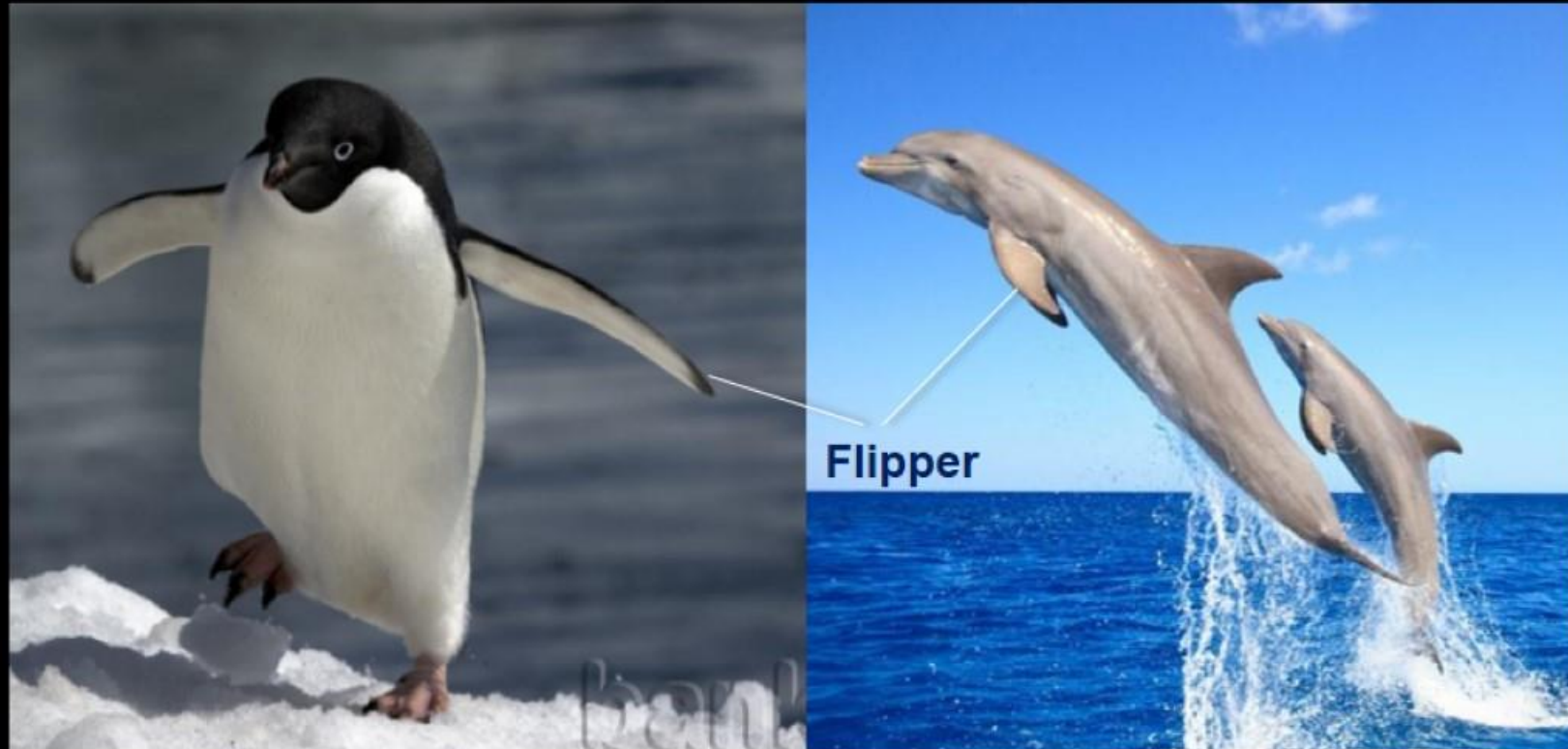
2. MORPHOLOGICAL & ANATOMICAL EVIDENCES

Analogous organs and Analogy



Examples

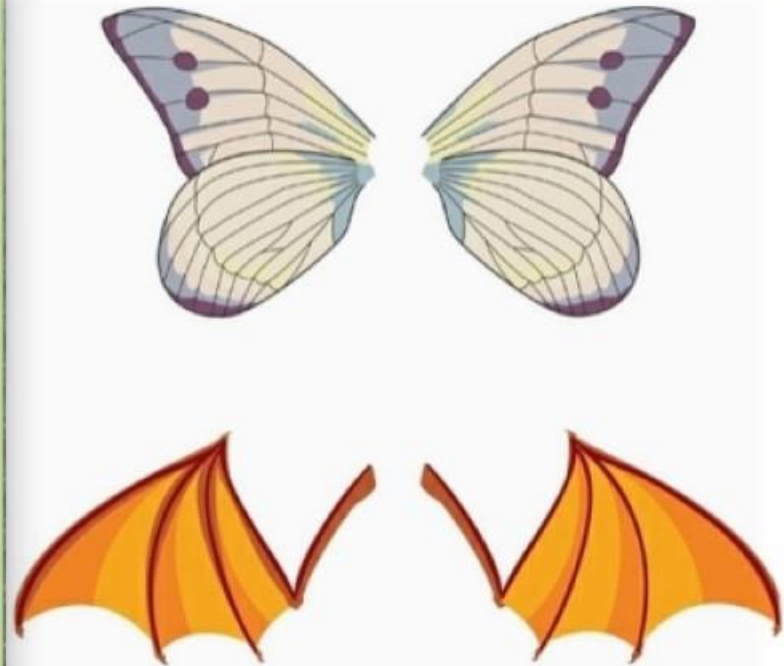
- Flipper of Penguins and Dolphins.



EVIDENCES FOR EVOLUTION

2. MORPHOLOGICAL & ANATOMICAL EVIDENCES

Analogous organs and Analogy



Examples

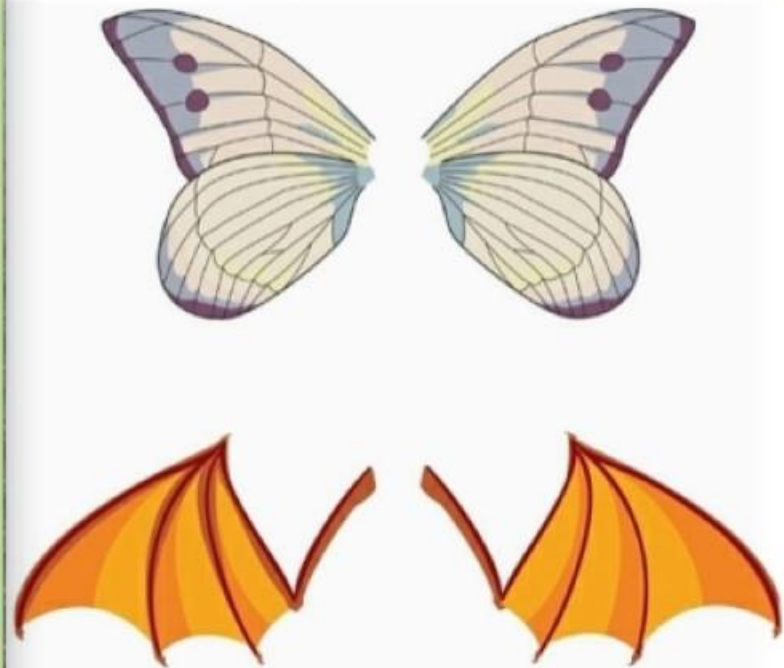
- **Sweet potato** (modified root) & **Potato** (modified stem).



EVIDENCES FOR EVOLUTION

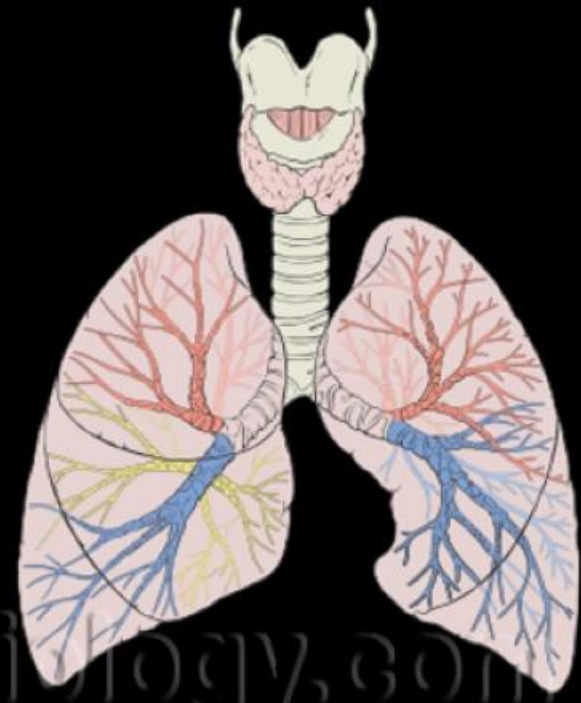
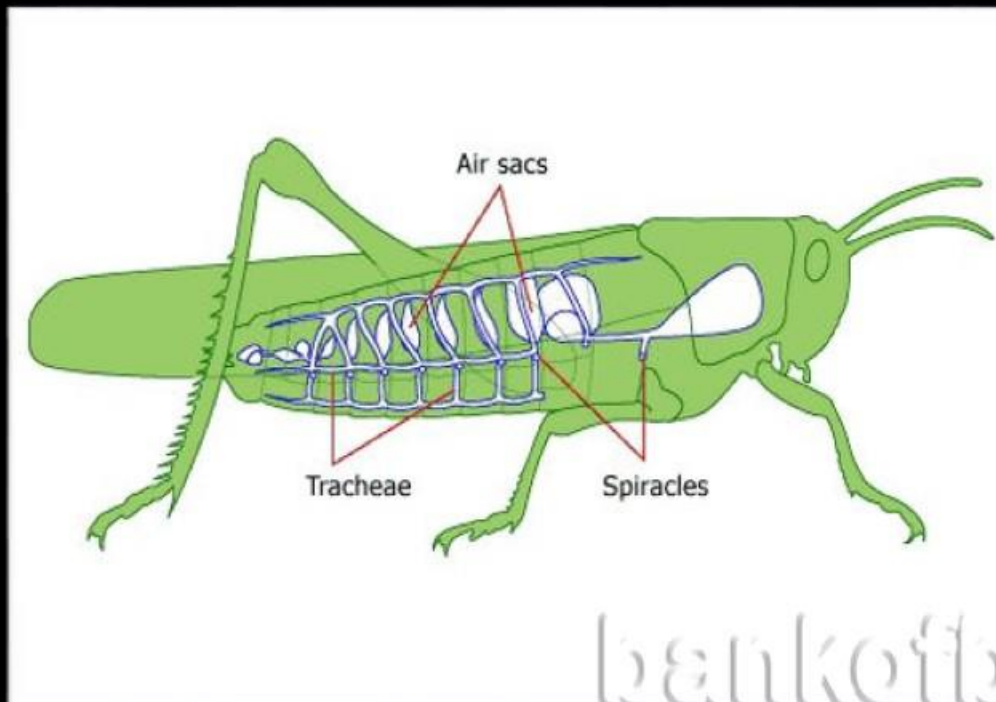
2. MORPHOLOGICAL & ANATOMICAL EVIDENCES

Analogous organs and Analogy



Examples

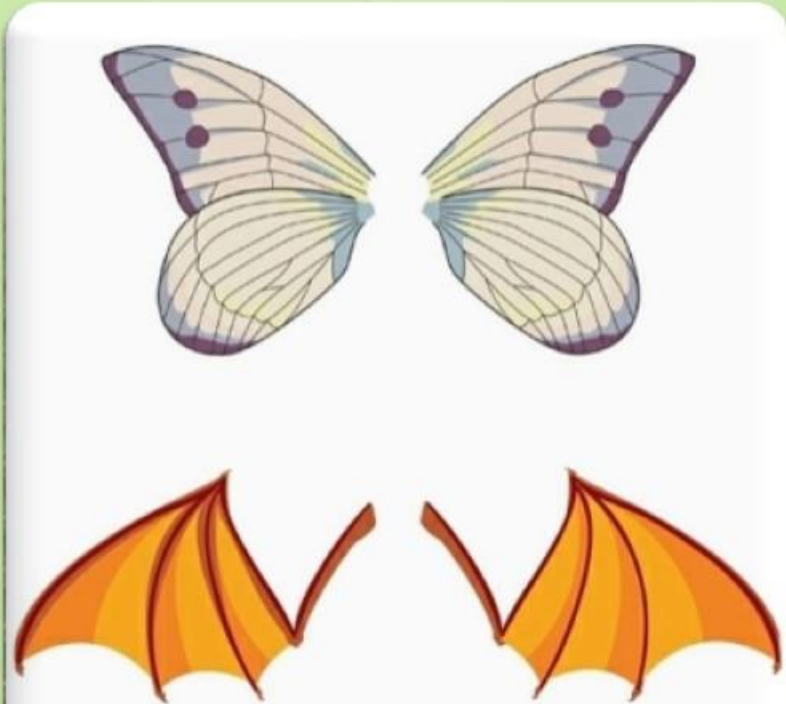
- **Trachea** of insects (from ectoderm) and **lungs** of vertebrates (from endoderm).



EVIDENCES FOR EVOLUTION

2. MORPHOLOGICAL & ANATOMICAL EVIDENCES

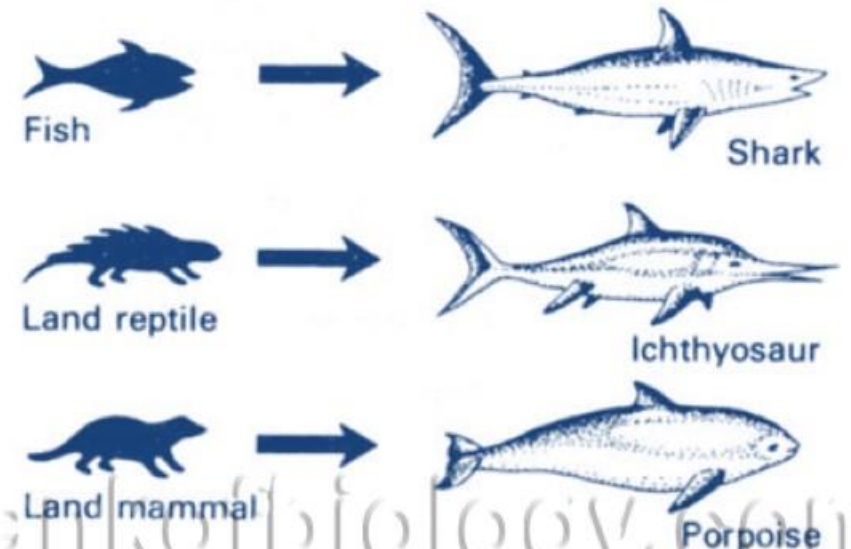
Analogous organs and Analogy



- ▶ Origin of analogous organs is due to **Convergent evolution**.
- ▶ Convergent evolution is the evolution by which **unrelated species** become **more similar** to survive and adapt in **similar environmental condition**.

Example for Convergent evolution:

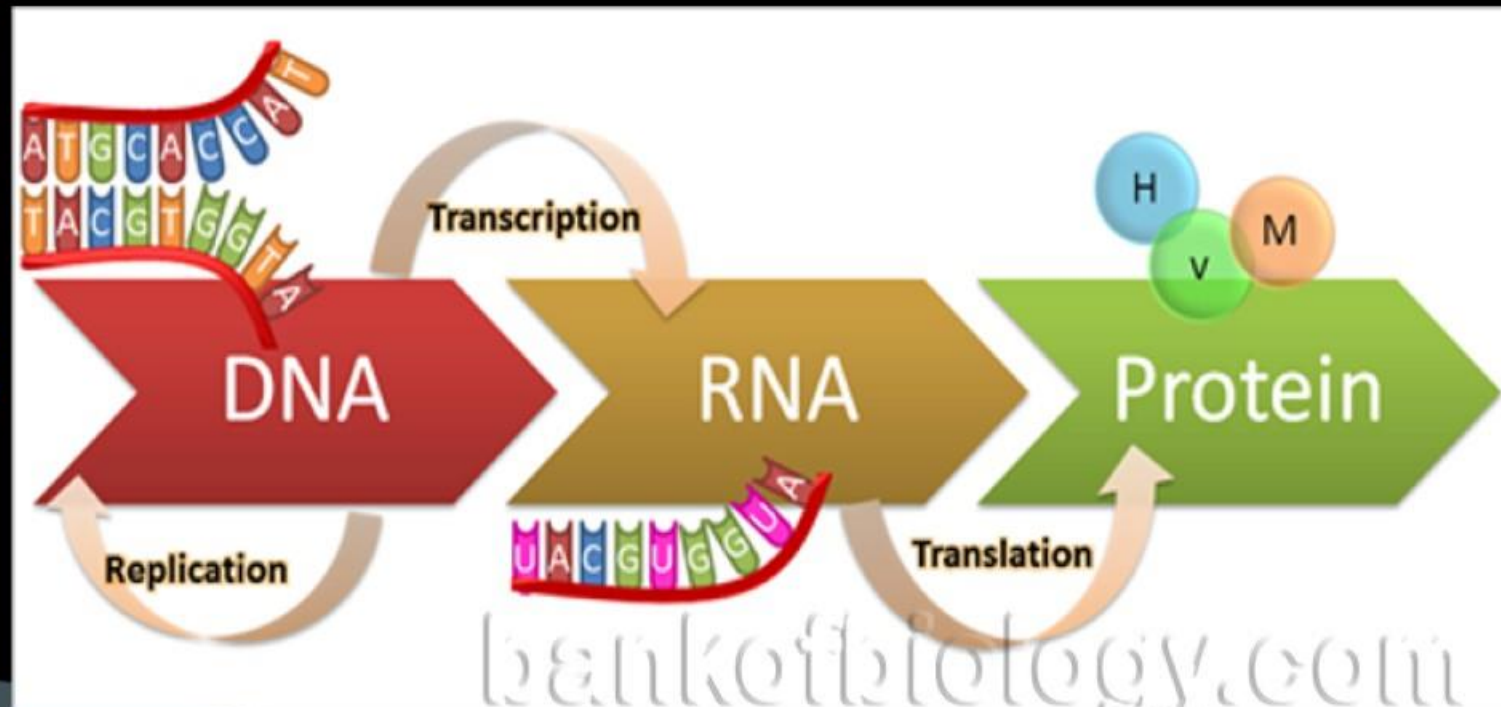
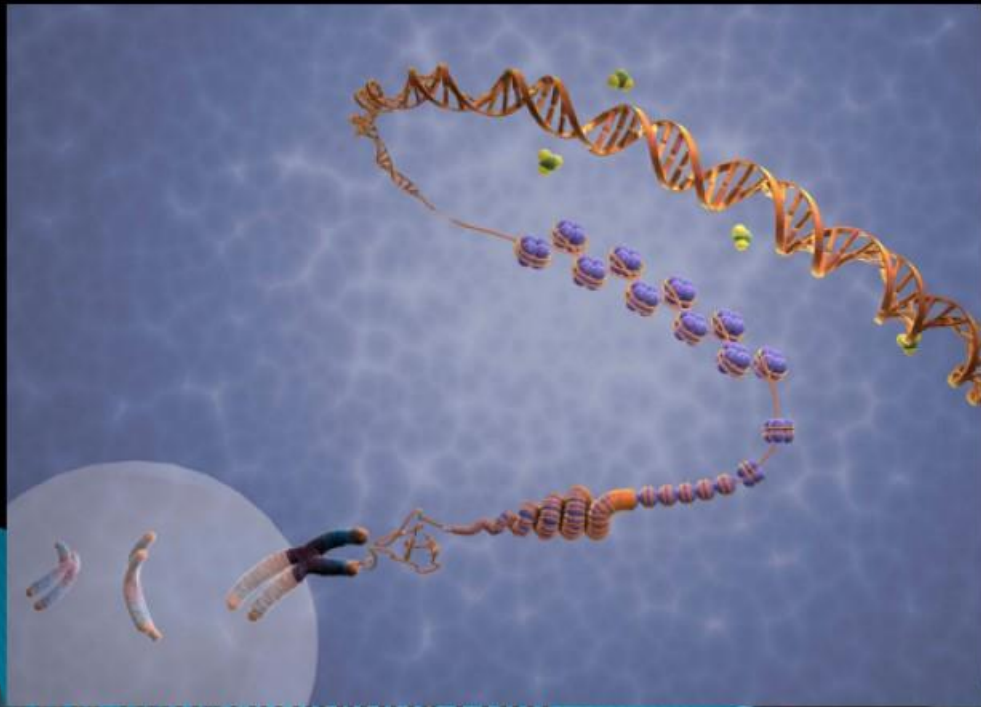
Fish, land reptile and land mammal are unrelated. But they evolved to more similar forms.



EVIDENCES FOR EVOLUTION

3. BIOCHEMICAL EVIDENCES

- ▶ Organisms show **similarities in proteins, genes, other biomolecules & metabolism.**
- ▶ It indicates common ancestry.



EVIDENCES FOR EVOLUTION

4. BIOGEOGRAPHICAL EVIDENCES (ADAPTIVE RADIATION)

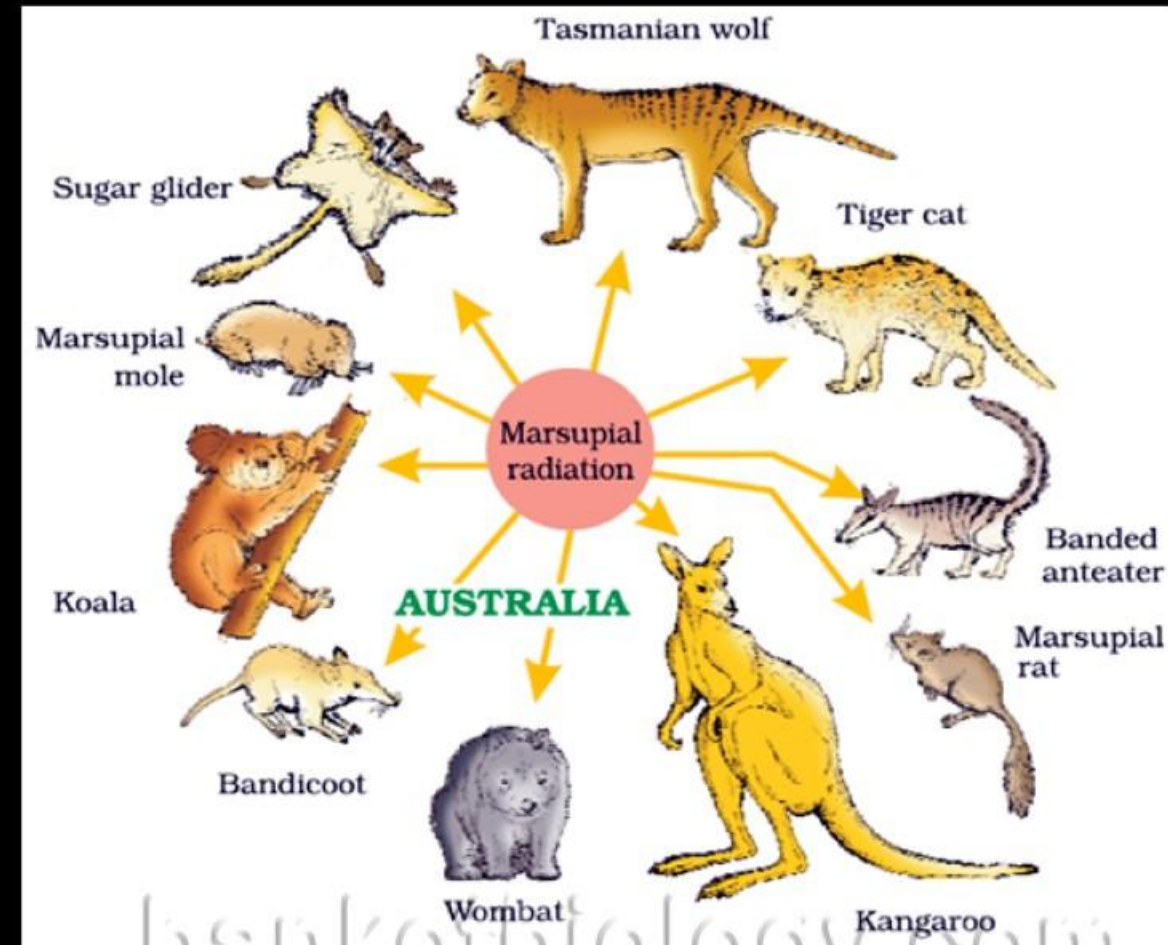
- **Adaptive radiation** (evolution by adaptation) is the evolution of different species in a geographical area starting from a point.
- E.g.
 - ✓ **Darwin's finches in Galapagos islands.**



EVIDENCES FOR EVOLUTION

4. BIOGEOGRAPHICAL EVIDENCES (ADAPTIVE RADIATION)

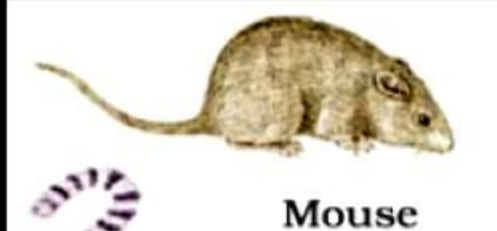
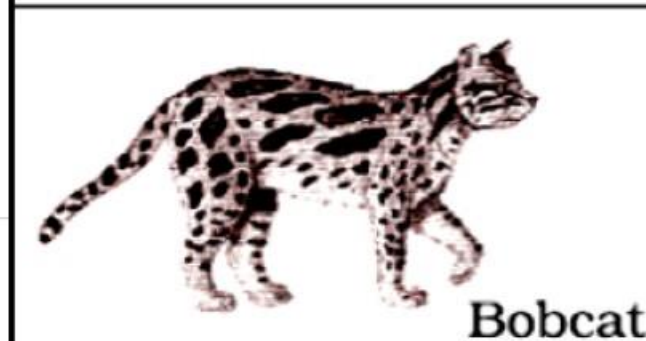
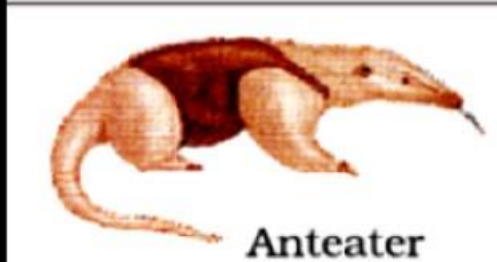
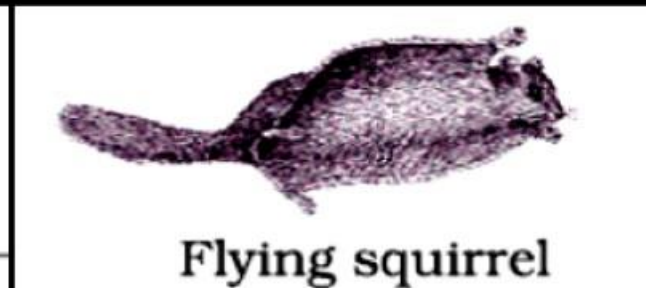
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- E.g.
 - ✓ **Darwin's finches in Galapagos islands.**
 - ✓ **Australian marsupials (Marsupial radiation).**



EVIDENCES FOR EVOLUTION

4. BIOGEOGRAPHICAL EVIDENCES (ADAPTIVE RADIATION)

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- E.g.
 - ✓ **Darwin's finches in Galapagos islands.**
 - ✓ **Australian marsupials (Marsupial radiation).**
 - ✓ **Placental mammals in Australia.**



EVIDENCES FOR EVOLUTION

4. BIOGEOGRAPHICAL EVIDENCES (ADAPTIVE RADIATION)

- ▶ When more than one adaptive radiation is appeared in an isolated geographical area, it results in **convergent evolution**.
- ▶ E.g. **Australian Marsupials and Placental mammals**.

Placental mammals	Australian marsupials
 Mole	 Marsupial mole
 Anteater	 Numbat (anteater)
 Mouse	 Marsupial mouse
 Lemur	 Spotted cuscus
 Flying squirrel	 Flying phalanger
 Bobcat	 Tasmanian tiger cat
 Wolf	 Tasmanian wolf

Placental mammals

Mole

Ant eater

Mouse

Lemur

Flying squirrel

Bobcat

Wolf

Australian Marsupials

Marsupial mole

Numbat (Ant eater)

Marsupial mouse

Spotted cuscus

Flying phalanger

Tasmanian tiger cat

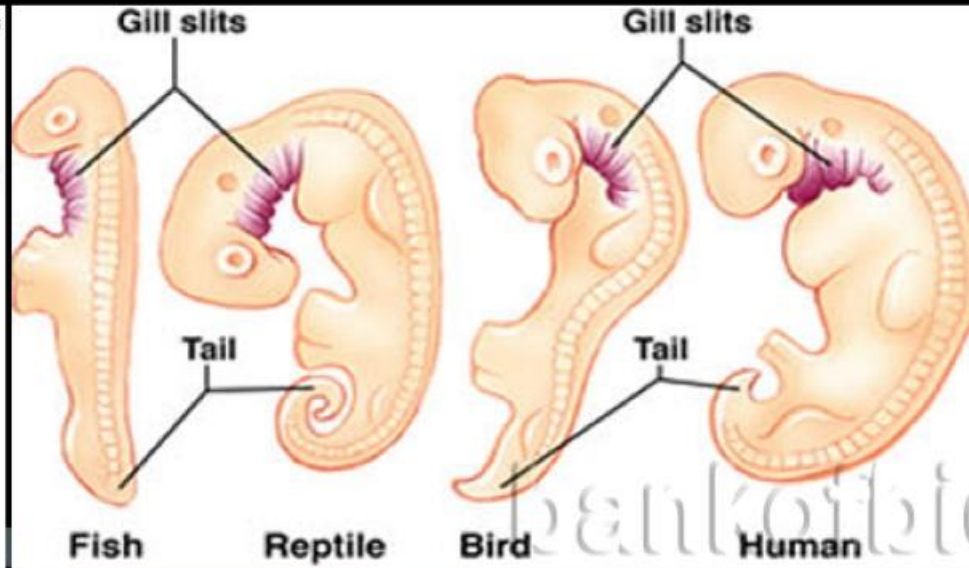
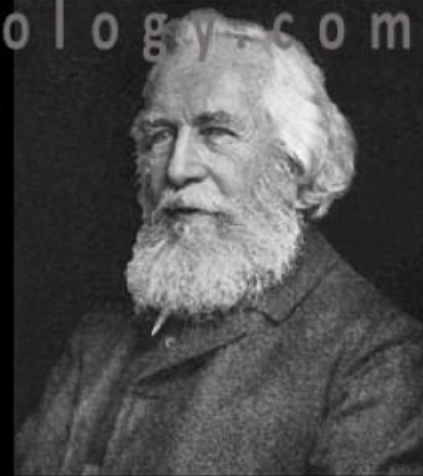
Tasmanian wolf

EVIDENCES FOR EVOLUTION

5. EMBRYOLOGICAL EVIDENCES

- ▶ Proposed by **Ernst Haeckel**.
- ▶ He observed that all **vertebrate embryos have some common features** that are absent in adult.
- ▶ E.g. all vertebrate embryos (including human) develop **vestigial gill slits** just behind the head. But it is functional only in fish and not found in other adult vertebrates.

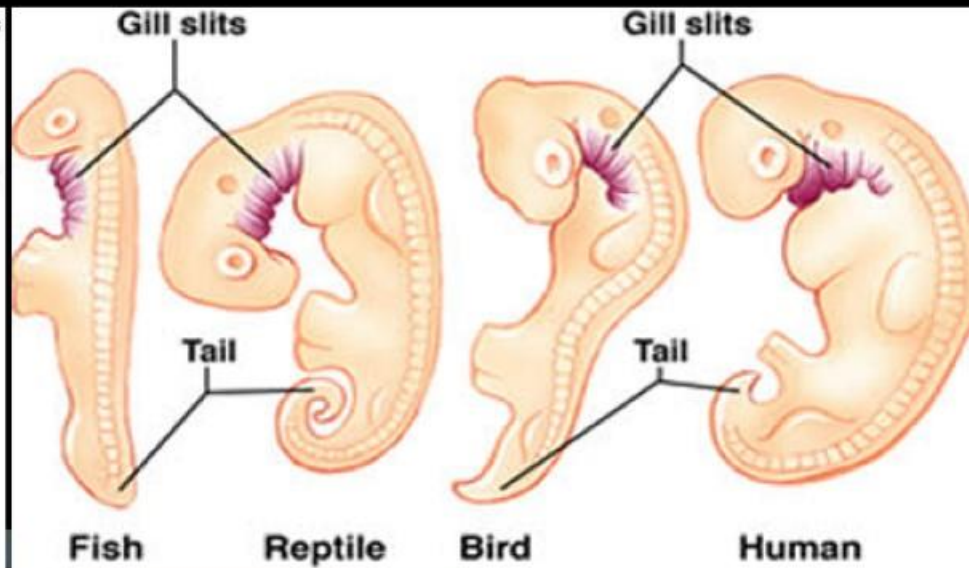
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EVIDENCES FOR EVOLUTION

5. EMBRYOLOGICAL EVIDENCES

- ▶ However, **Karl Ernst von Baer** rejected this proposal.
- ▶ He noted that embryos never pass through the adult stages of other animals.



EVIDENCES FOR EVOLUTION

6. EVIDENCES FOR EVOLUTION BY NATURAL SELECTION

- **Natural selection** is the process by which the organisms that are best suited for their environment survive and reproduce.
- Some examples are given below:



Industrial melanism



Development of **resistant varieties** in organisms against herbicides, pesticides, antibiotics or drugs etc.

These are the examples for **natural selection by anthropogenic action** (evolution due to human activities).

EVIDENCES FOR EVOLUTION

6. EVIDENCES FOR EVOLUTION BY NATURAL SELECTION



**Industrial
melanism**



- In England, before industrialization (1850s): There were more **white winged moths (*Biston betularia*)** on trees than **dark winged or melanised moths (*Biston carbonaria*)**.
- **After industrialization (1920):** More dark winged moths and less white winged moths.



Before industrialization



After industrialization

EVIDENCES FOR EVOLUTION

6. EVIDENCES FOR EVOLUTION BY NATURAL SELECTION

REASON

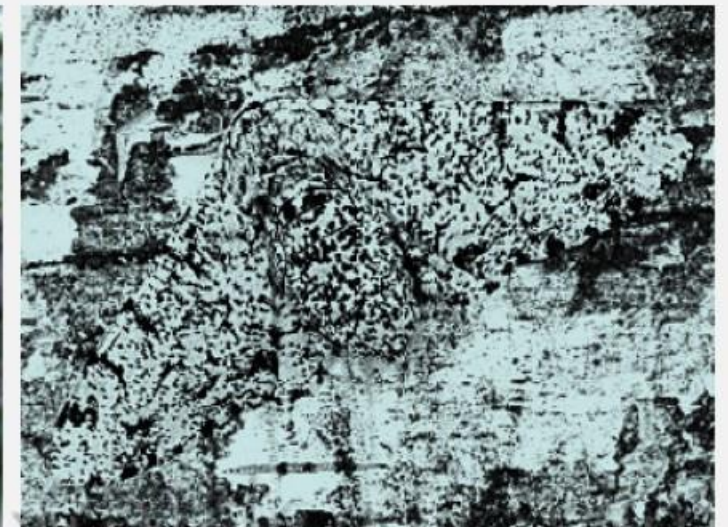
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Before industrialization:

- There was thick growth of white coloured **lichen** covered the trees.
- In that background, the white winged moths survived but the dark coloured moths were picked out by predators.



**Industrial
melanism**



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EVIDENCES FOR EVOLUTION

6. EVIDENCES FOR EVOLUTION BY NATURAL SELECTION

REASON

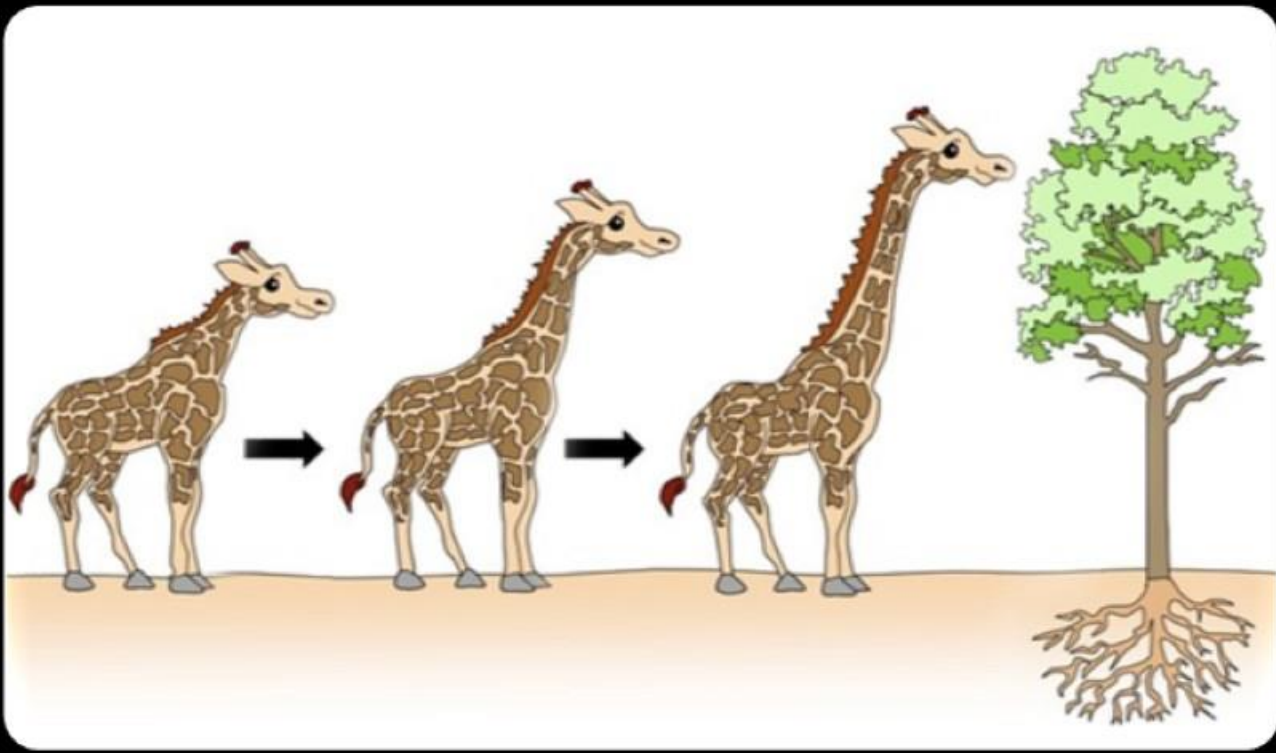
After industrialization:

- Tree trunks became dark due to industrial smoke & soots. No lichens.
- Under this condition, white winged moth did not survive because the predators identified them easily.
- Dark winged moth survived because of suitable dark background, i.e. predators could not identify them.



**Industrial
melanism**





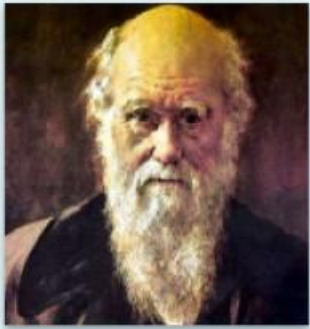
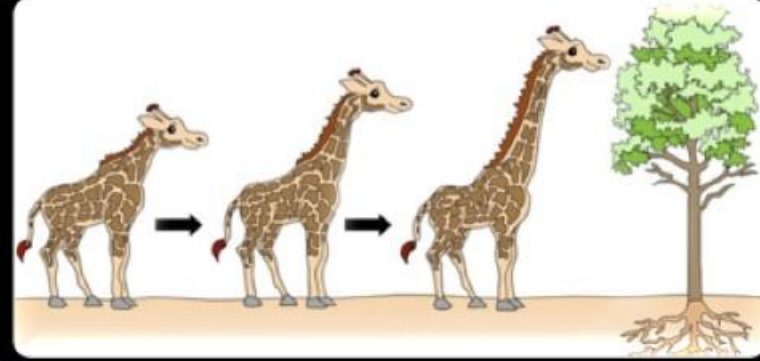
THEORIES OF BIOLOGICAL EVOLUTION

THEORIES OF BIOLOGICAL EVOLUTION



1

Theory of Lamarck (Lamarckism or Theory of Inheritance of Acquired characters)



2

Darwinian Theory (Darwinism or Theory of Natural selection)



3

Mutation Theory of de Vries



THEORIES OF BIOLOGICAL EVOLUTION

LAMARCKISM (THEORY OF INHERITANCE OF ACQUIRED CHARACTERS)



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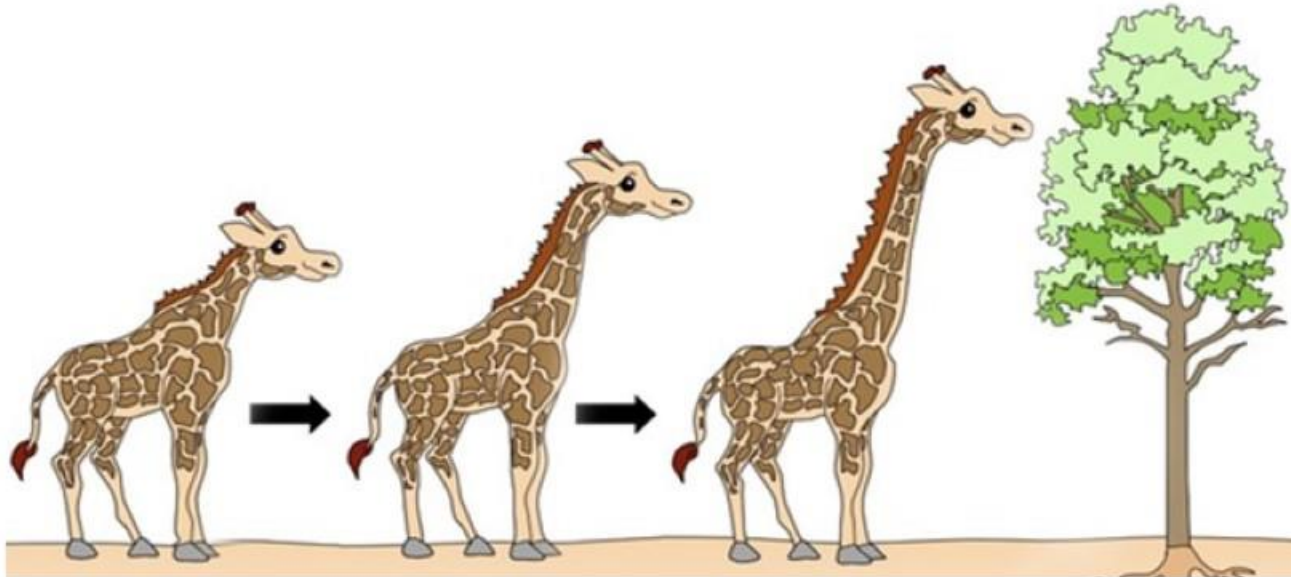
- It is proposed by **Lamarck**.
- It states that evolution of life forms occurred by the **inheritance of acquired characters**.

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THEORIES OF BIOLOGICAL EVOLUTION

LAMARCKISM (THEORY OF INHERITANCE OF ACQUIRED CHARACTERS)

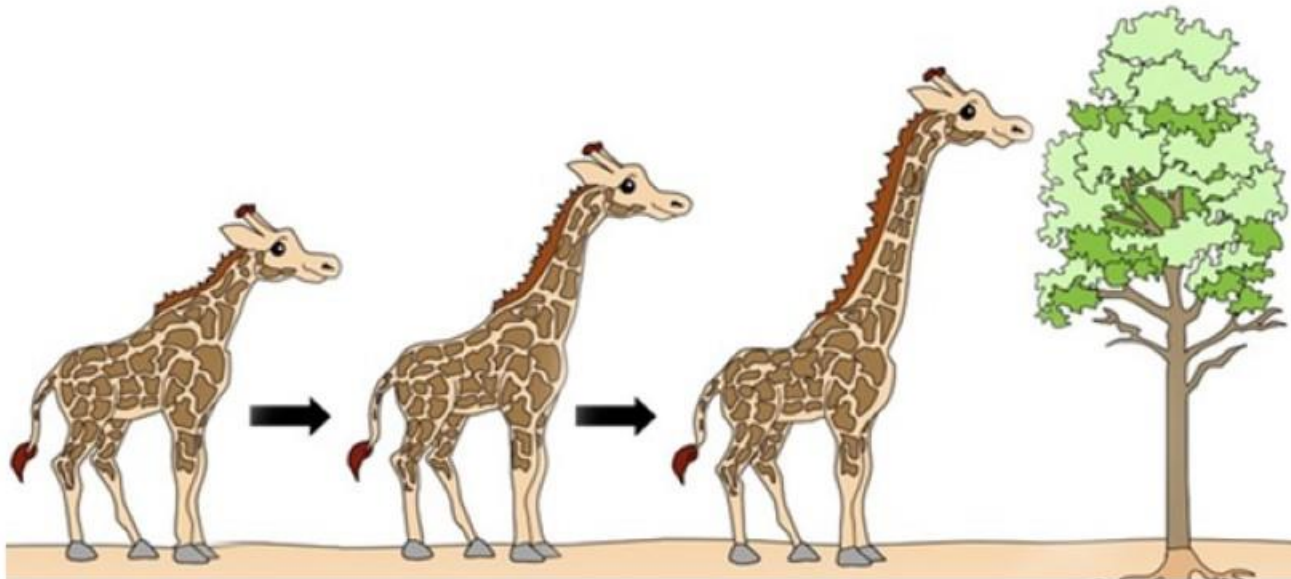
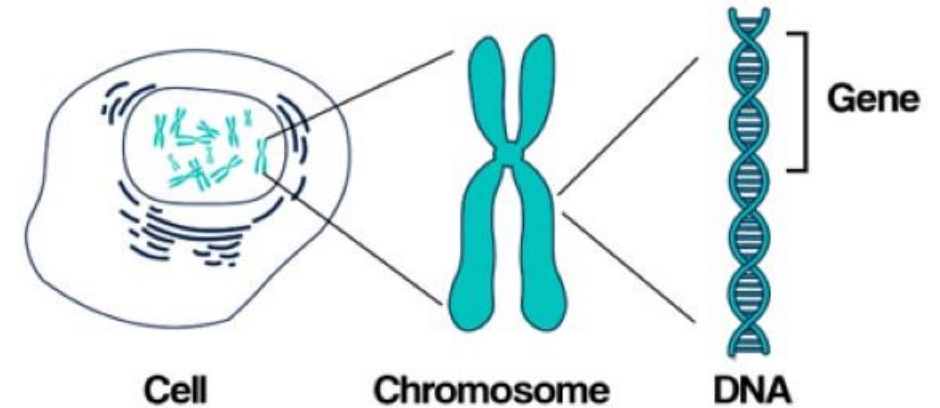
- Acquired characters are developed by **use and disuse** of organs.
 - **Evolution by use of organs:** E.g. **Long neck of giraffe** is due to continuous elongation to forage leaves on trees. This acquired character was inherited to succeeding generations.
 - **Evolution by disuse:** E.g. Disappearance of limbs in snakes.



THEORIES OF BIOLOGICAL EVOLUTION

LAMARCKISM (THEORY OF INHERITANCE OF ACQUIRED CHARACTERS)

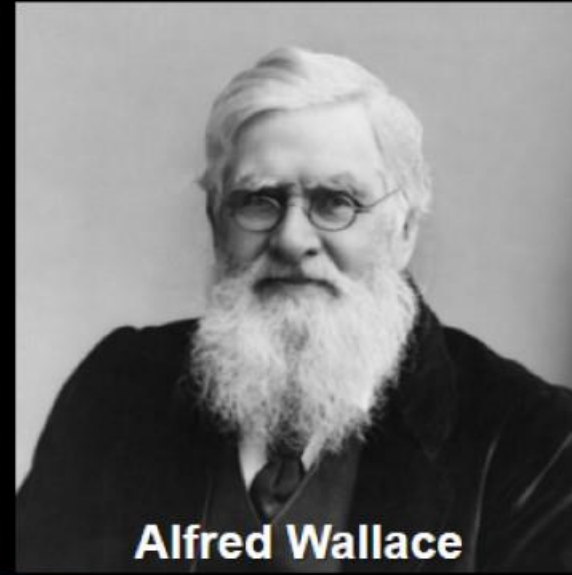
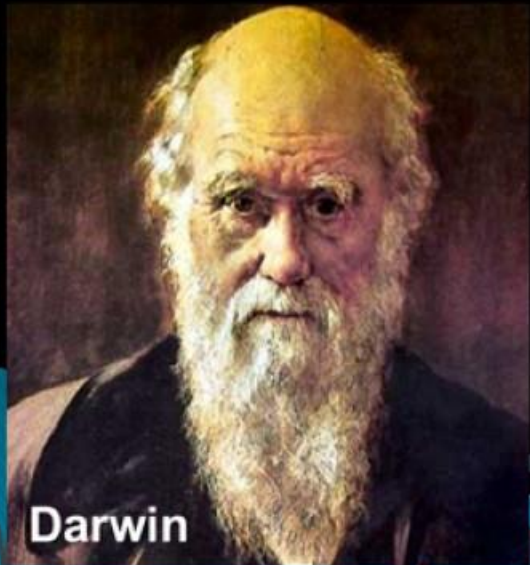
This theory was eliminated out because it is proved that the **characters are inherited only through genes.**



THEORIES OF BIOLOGICAL EVOLUTION

DARWINISM (THEORY OF NATURAL SELECTION)

- ▶ Proposed by **Charles Darwin**.
- ▶ It was based on observations during a sea voyage in a sail ship called **H.M.S. Beagle**.
- ▶ **Alfred Wallace** (a naturalist worked in Malay Archipelago) had also come to similar conclusions.
- ▶ Work of **Thomas Malthus** on populations influenced Darwin.



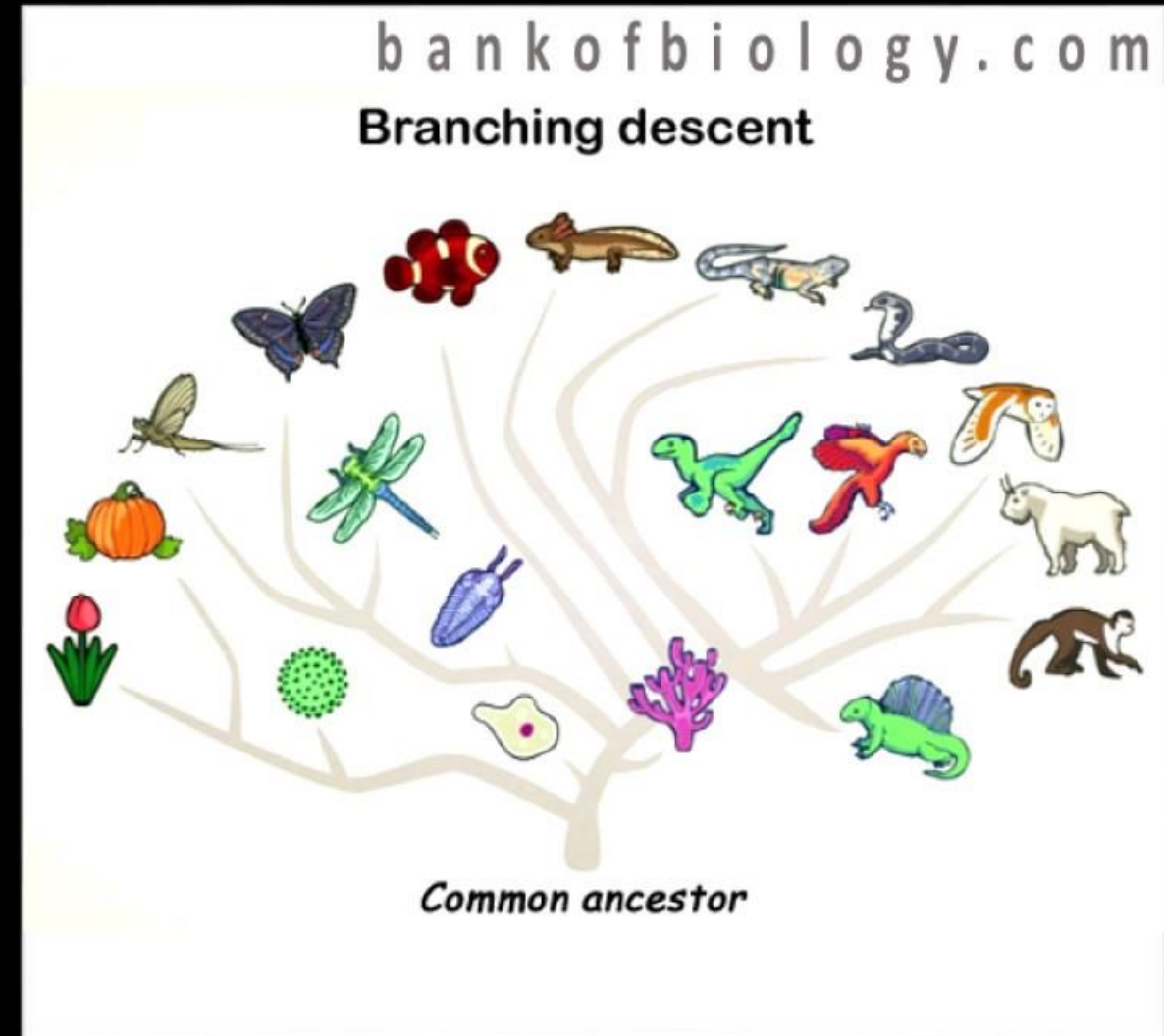
THEORIES OF BIOLOGICAL EVOLUTION

DARWINISM (THEORY OF NATURAL SELECTION)

Darwinism is based on 2 key concepts:

1. **Branching descent:**

It explains that all organisms are modified descendants of previous life forms.



THEORIES OF BIOLOGICAL EVOLUTION

DARWINISM (THEORY OF NATURAL SELECTION)

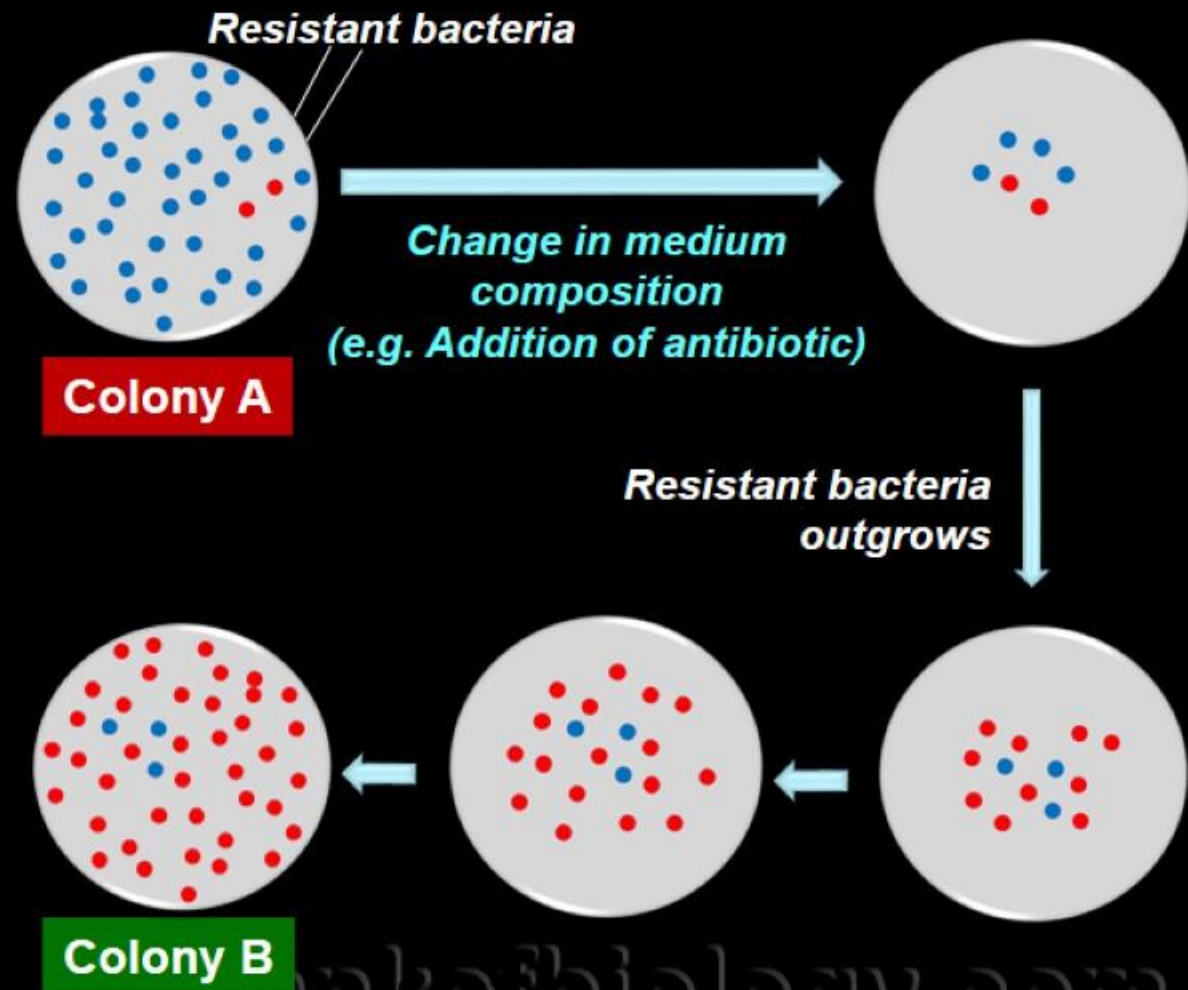
Darwinism is based on 2 key concepts:

1. **Branching descent:**

It explains that all organisms are modified descendants of previous life forms.

2. **Natural selection:**

Consider a bacterial **colony A** growing on a given medium. If the medium composition is changed, only a part of the population can survive under new condition. This **variant population (B)** outgrows the others and appears as new species, i.e. **B is better than A under new condition**. Thus, nature selects for fitness.



THEORIES OF BIOLOGICAL EVOLUTION

DARWINISM (THEORY OF NATURAL SELECTION)



Natural selection is based on the following facts:

Heritable minor variations

Overproduction

Limited natural resources

Struggle for existence

Survival of the fittest

THEORIES OF BIOLOGICAL EVOLUTION

DARWINISM (THEORY OF NATURAL SELECTION)

1. Heritable minor variations:

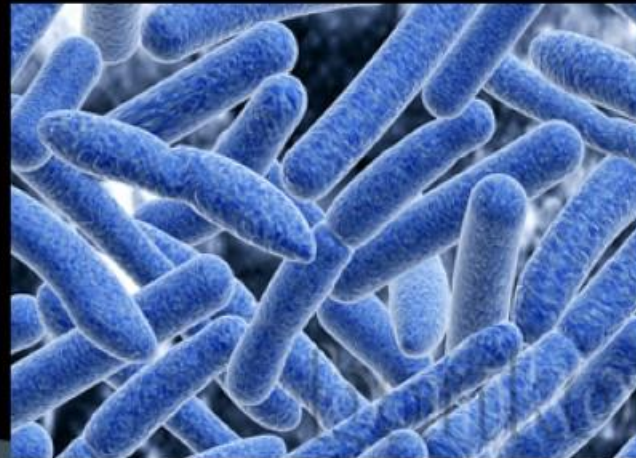
It is either beneficial or harmful to the organisms.

2. Overproduction:

Population size grows exponentially due to maximum reproduction (E.g. bacterial population).

3. Limited natural resources:

Resources are not increased in accordance with the population size.



THEORIES OF BIOLOGICAL EVOLUTION

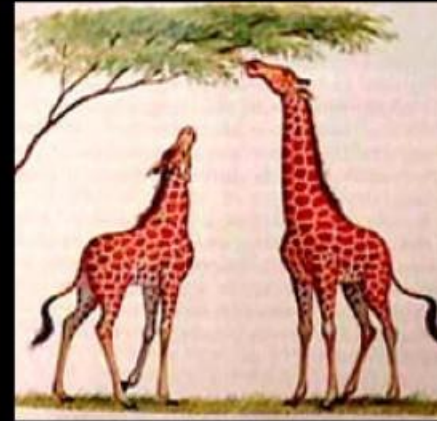
DARWINISM (THEORY OF NATURAL SELECTION)

4. Struggle for existence:

It is the competition among organisms for resources so that population size is limited.

5. Survival of the fittest:

In struggle for existence, organisms with beneficial variations can utilize resources better. Hence, they survive and reproduce. This is called **Survival of the fittest**. It leads to a change in population characteristics and new forms appear.



Darwin ignored about origin of variation and mechanism of evolution or speciation.

THEORIES OF BIOLOGICAL EVOLUTION

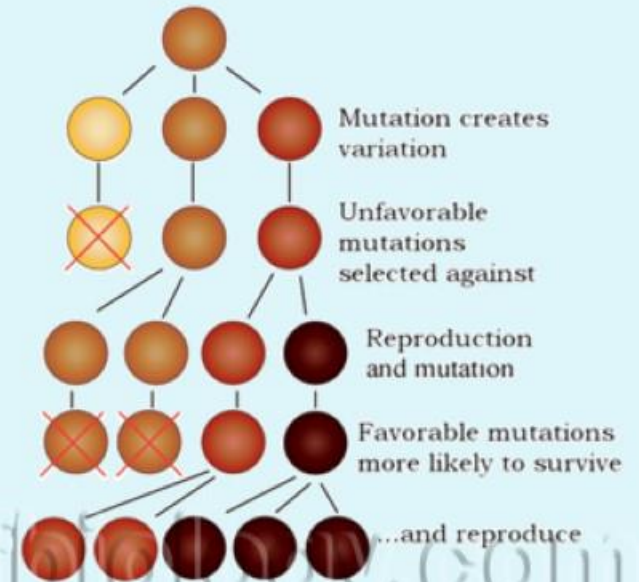
MECHANISM OF EVOLUTION



- ▶ Hugo de Vries proposed **Mutation Theory** of evolution.
- ▶ He conducted some experiments on **evening primrose** (*Oenothera lamarckiana*) and believed that evolution takes place through mutation and not by minor variation.



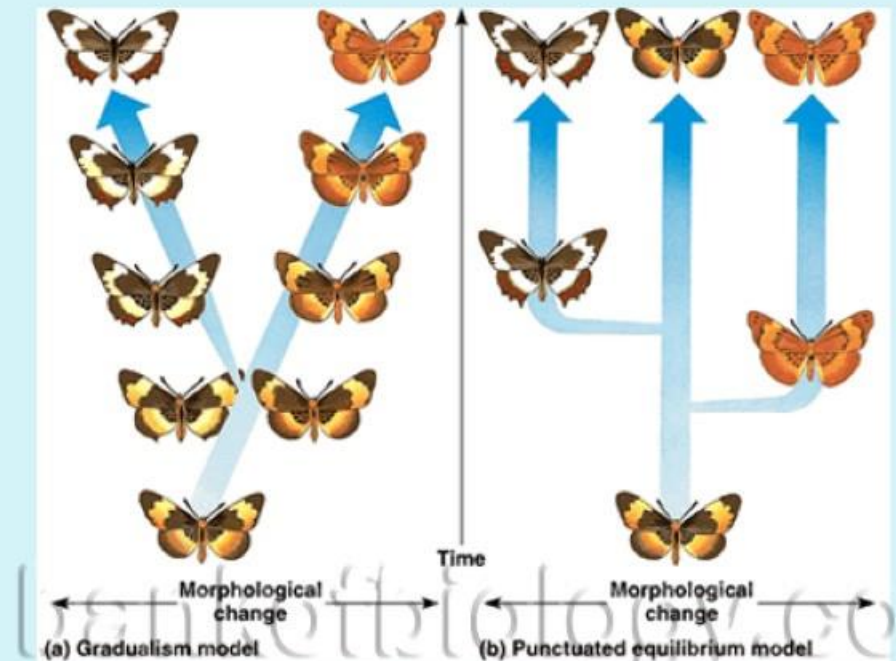
Evening primrose

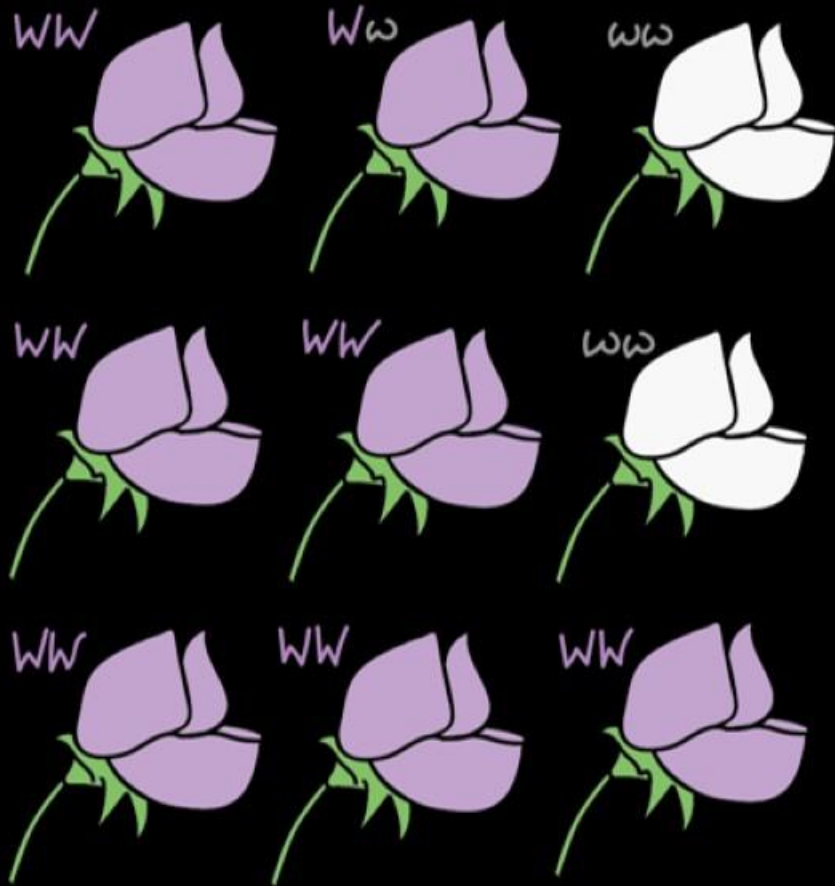


THEORIES OF BIOLOGICAL EVOLUTION

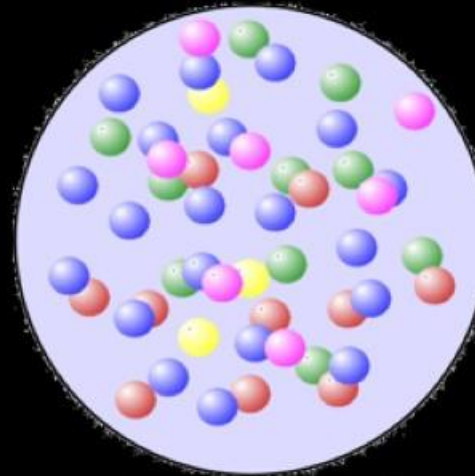
MECHANISM OF EVOLUTION

- ▶ **Darwinian variation** is **minor, slow & directional**. It results in **gradual evolution**.
- ▶ **Mutational variation** is **sudden, random and directionless**. Here, speciation is by **saltation** (single step, large mutation).
- ▶ Mutation is the origin of variation for evolution.

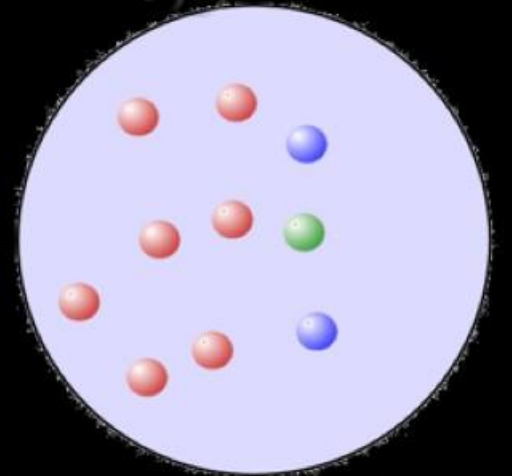




Initial frequency distribution	
	0.20
	0.20
	0.20
	0.20
	0.20



5th generation frequency distribution	
	0.40
	0.06
	0.20
	0.14
	0.20

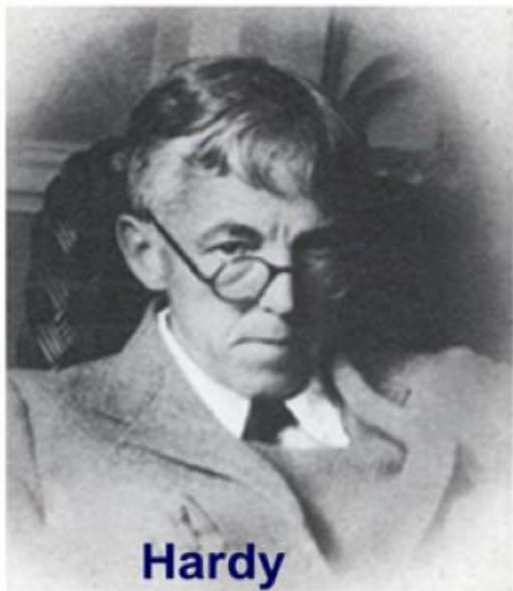


10th generation frequency distribution	
	0.20
	0.00
	0.10
	0.00
	0.70

HARDY-WEINBERG PRINCIPLE

HARDY- WEINBERG PRINCIPLE

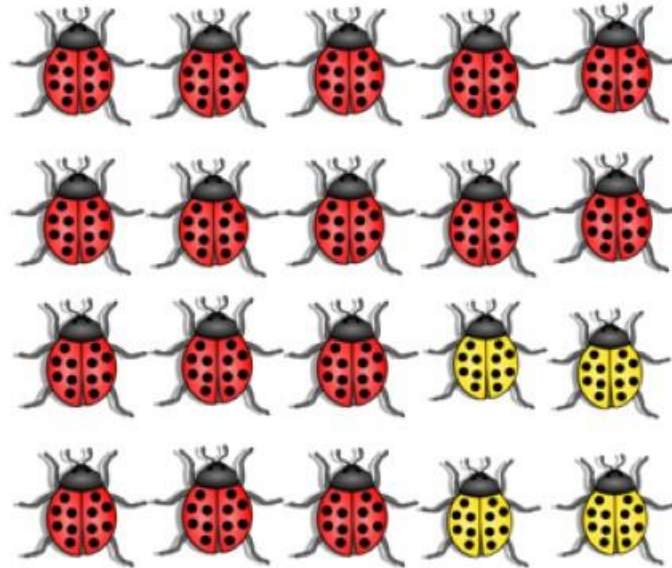
- It says that **allele frequencies*** in a population are stable and is constant from generation to generation in the absence of disturbing factors.
- The **gene pool** (total genes and their alleles in a population) remains a constant. This is called **genetic equilibrium (Hardy-Weinberg equilibrium)**.
- **Sum total of all the allelic frequencies = 1**



Hardy



Weinberg



A population of 20 beetles.
Each beetle is a gene pool.
Their totality is the gene pool of that population.

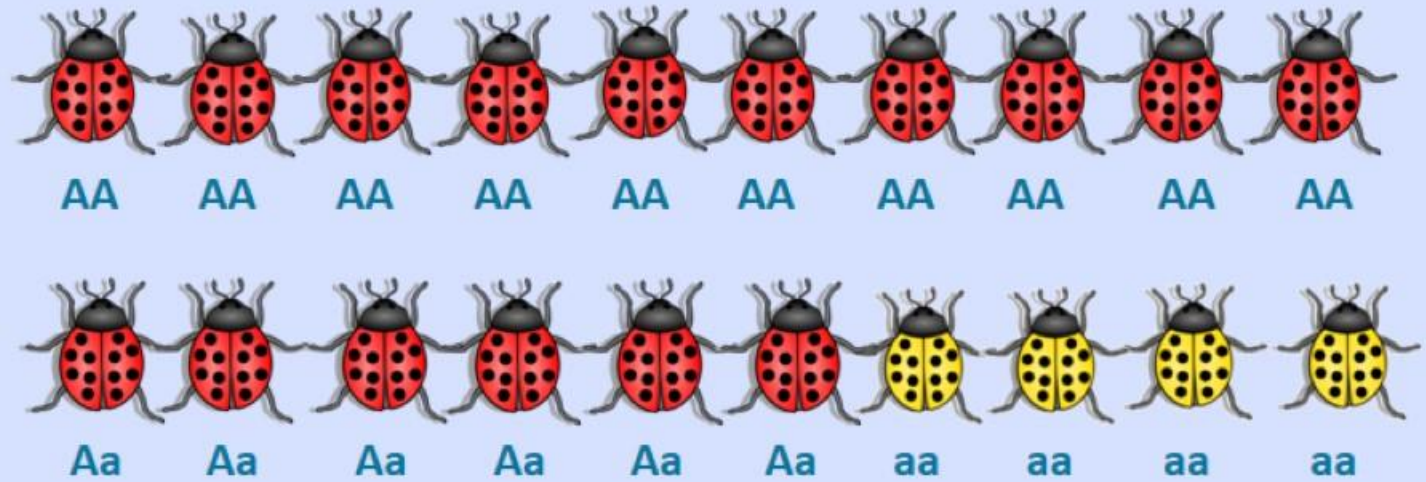
* **Allele frequency** refers to how frequently a particular allele appears in a population.

HARDY- WEINBERG PRINCIPLE

- E.g. Consider, in a diploid, p & q are the frequencies of alleles A and a respectively.
 - Frequency of $AA = p^2$
 - Frequency of $aa = q^2$
 - Frequency of $Aa = 2pq$
 - Hence $p^2 + 2pq + q^2 = 1$
[binomial expansion of $(p+q)^2$]

Change of frequency of alleles in a population disturbs Hardy-Weinberg equilibrium.

This change is due to evolution.



- Here, total number of alleles A & $a = 40$ ($A = 26$ & $a = 14$)
 $\therefore$ Frequency of $A = p = 26/40 = 0.65$
Frequency of $a = q = 14/40 = 0.35$ } Total allelic frequency $(p+q) = 1$
- No. of beetles = 20 (Genotypes: $AA = 10$, $Aa = 6$, $aa = 4$)
Frequency of genotype $AA = 10/20 = 0.5$
Frequency of genotype $Aa = 6/20 = 0.3$
Frequency of genotype $aa = 4/20 = 0.2$

HARDY- WEINBERG PRINCIPLE

FACTORS AFFECTING HARDY-WEINBERG EQUILIBRIUM

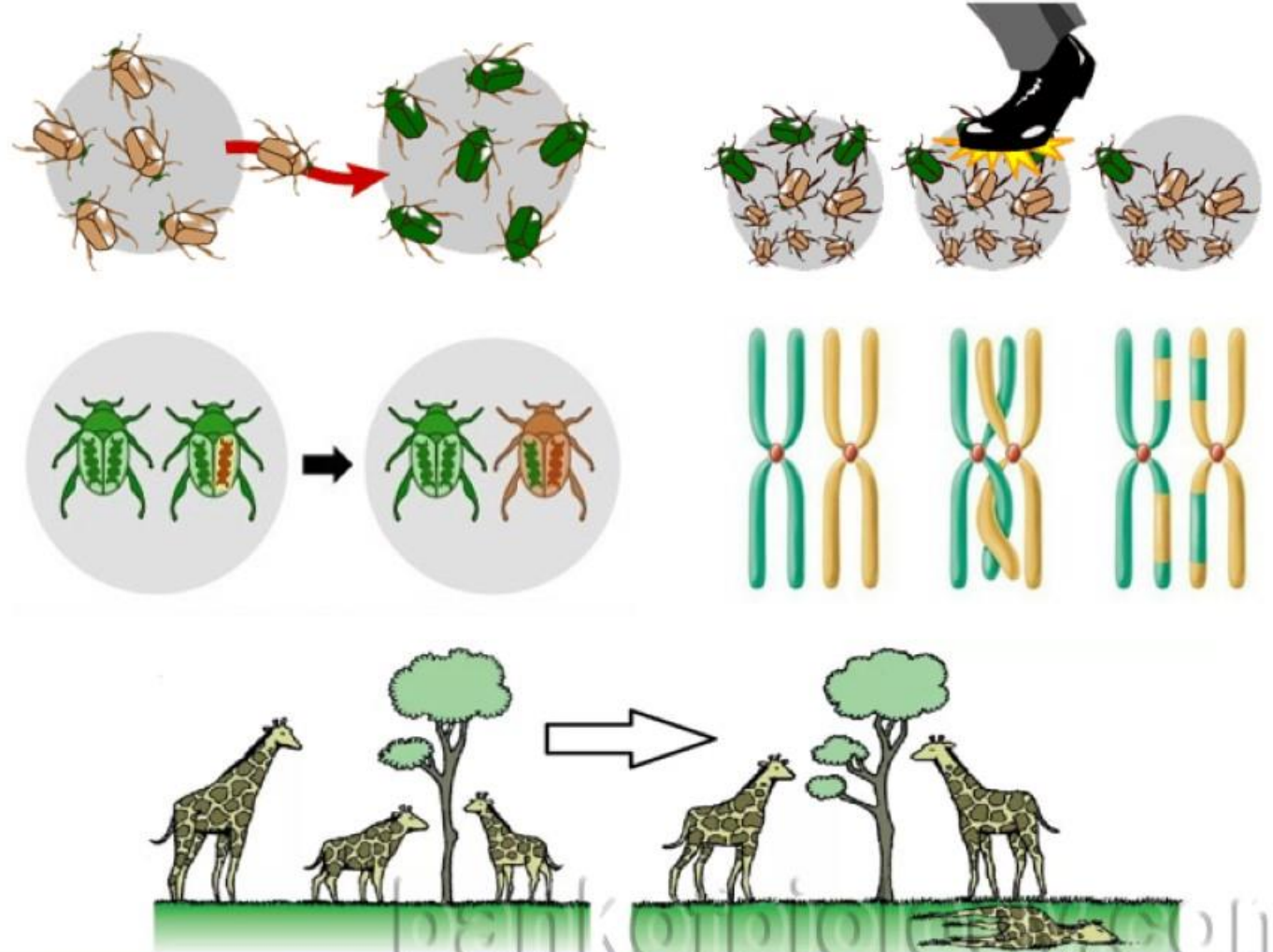
Gene migration (gene flow)

Genetic drift

Mutation

Genetic recombination

Natural selection

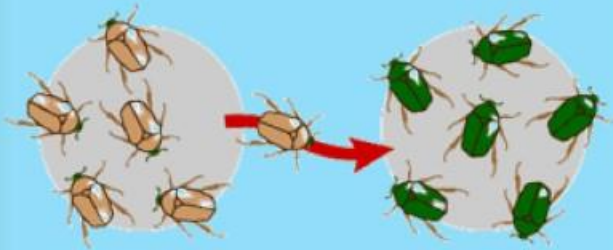


HARDY-WEINBERG PRINCIPLE

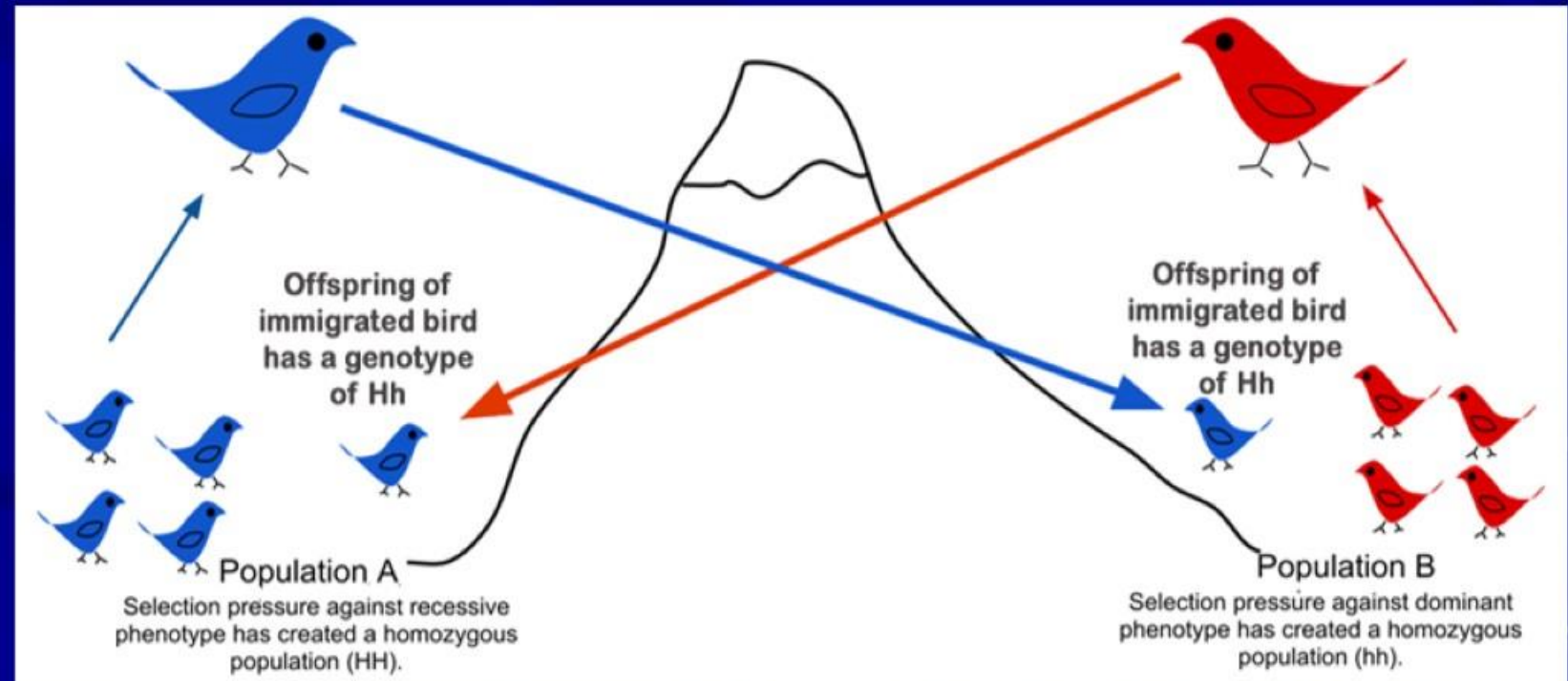
FACTORS AFFECTING HARDY-WEINBERG EQUILIBRIUM

1

GENE MIGRATION



- ❖ It is the **gene flow** from one population to another.
- ❖ Here gene frequencies change in both populations.
- ❖ Gene flow occurs if migration happens multiple times.



HARDY- WEINBERG PRINCIPLE

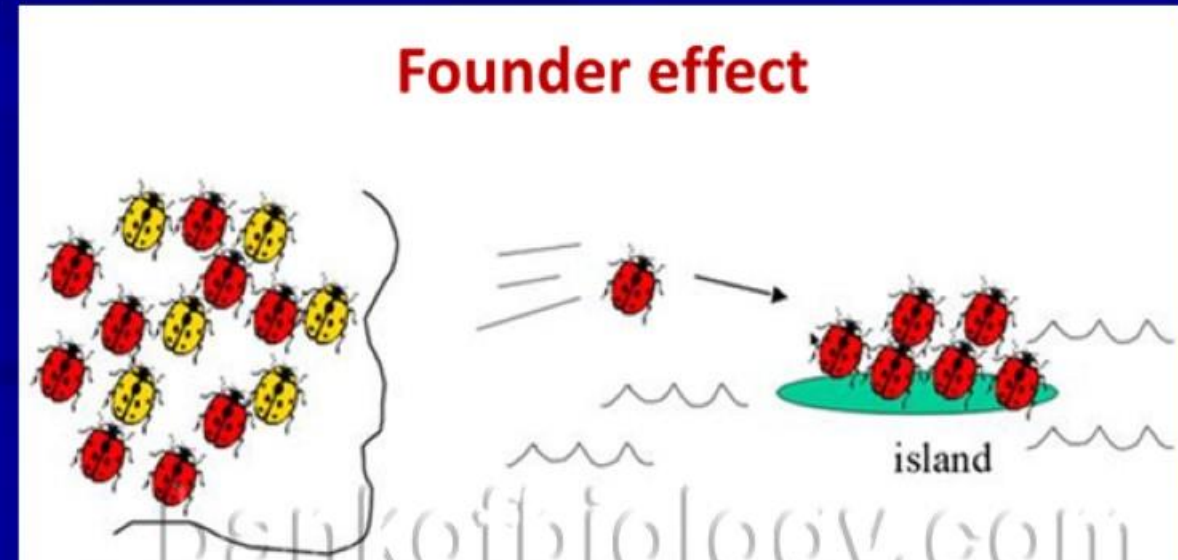
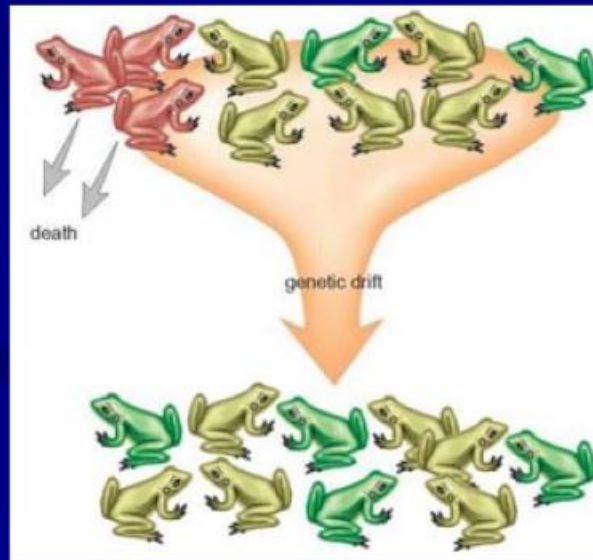
FACTORS AFFECTING HARDY-WEINBERG EQUILIBRIUM

2

GENETIC DRIFT



- ❖ Gene flow by chance causing change in frequency.
- ❖ Sometimes, change in frequency is so different in the new sample of population that they become a different species.
- ❖ The original drifted population becomes founders and the effect is called **founder effect**. bankofbiology.com

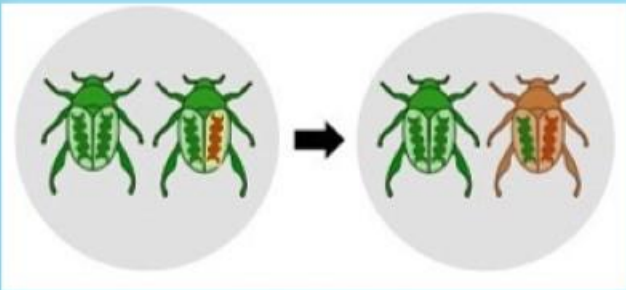


HARDY- WEINBERG PRINCIPLE

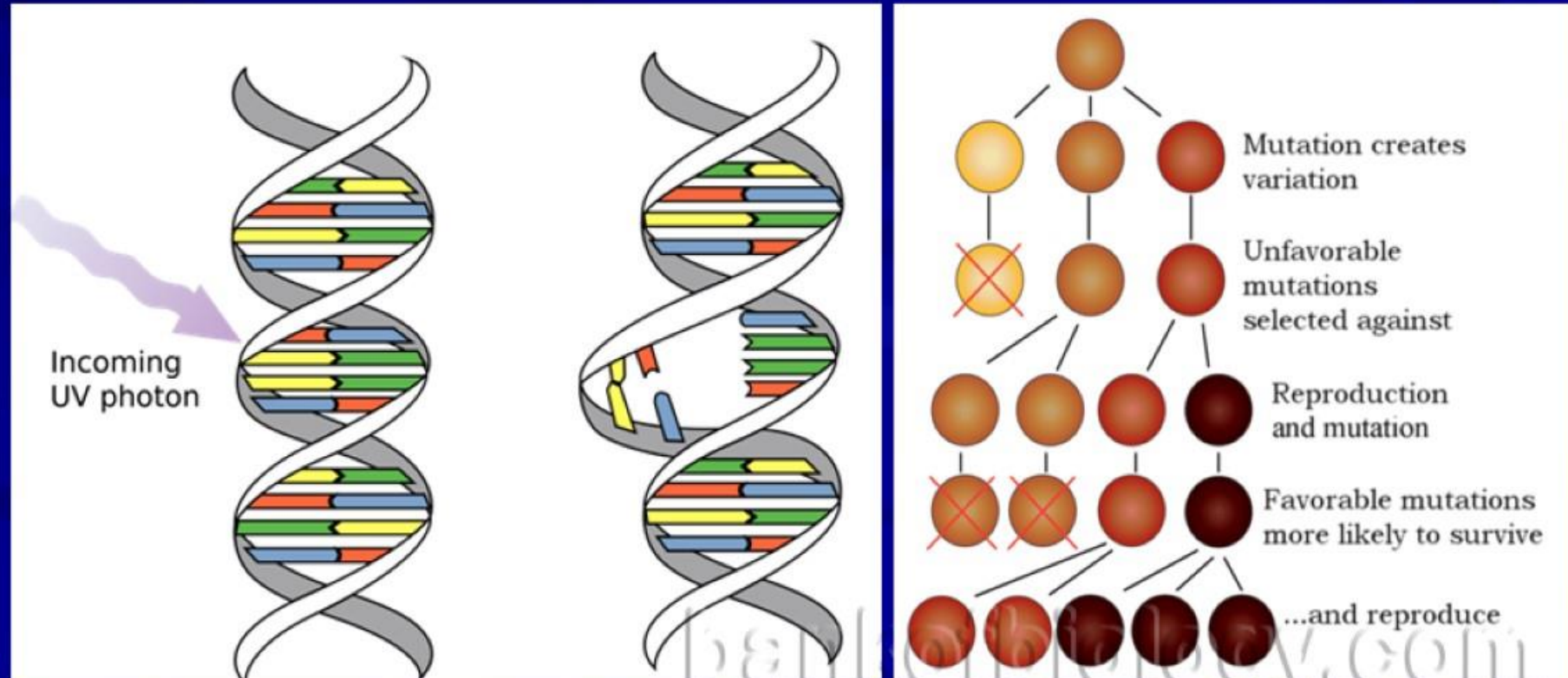
FACTORS AFFECTING HARDY-WEINBERG EQUILIBRIUM

3

MUTATION



- ❖ It results in formation of new phenotypes.
- ❖ Over few generations, this leads to speciation.

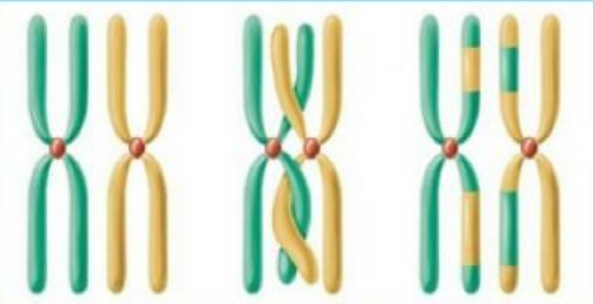


HARDY-WEINBERG PRINCIPLE

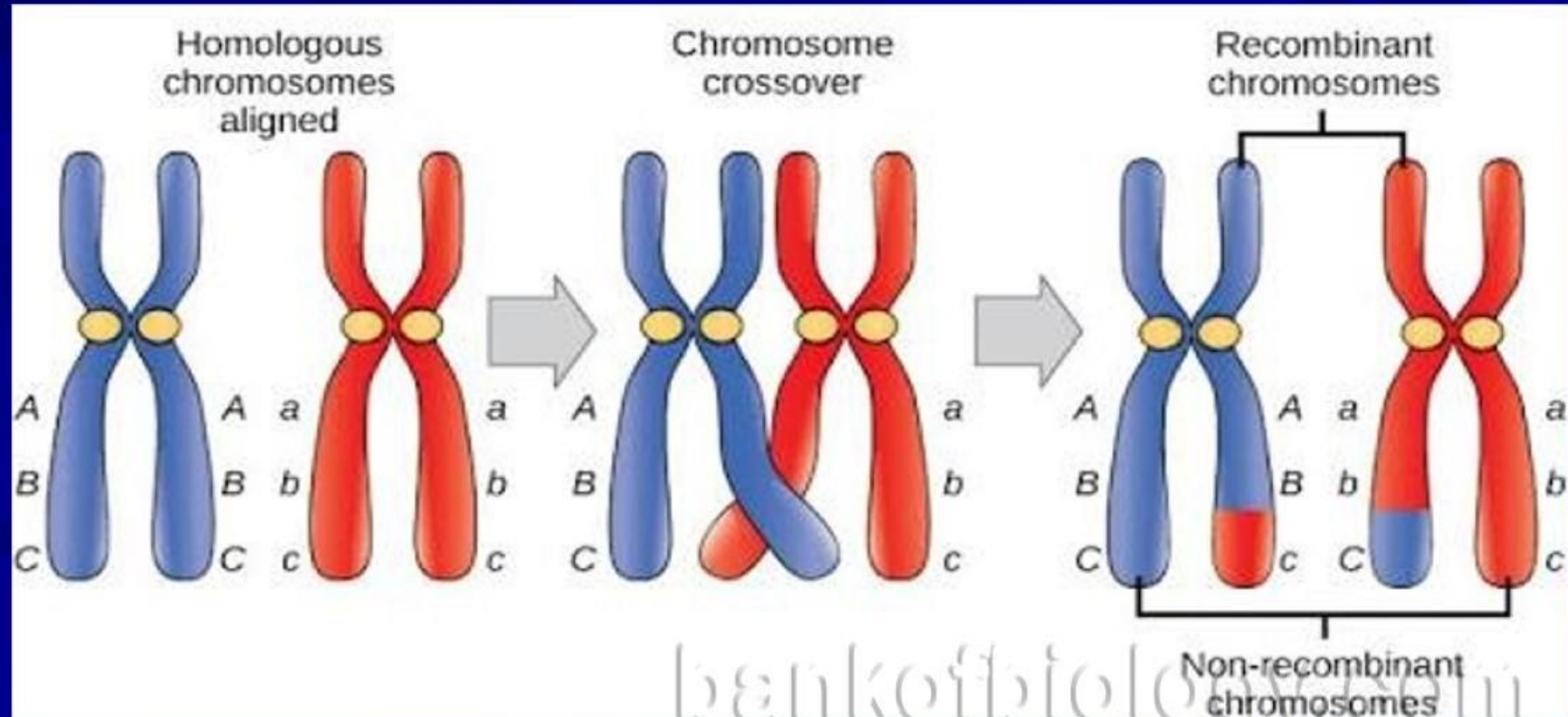
FACTORS AFFECTING HARDY-WEINBERG EQUILIBRIUM

4

GENETIC RECOMBINATION



- ❖ It is the reshuffling of gene combinations during crossing over resulting in genetic variation.

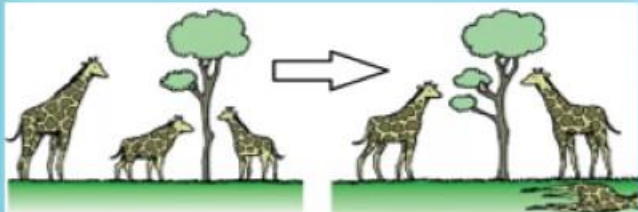


HARDY-WEINBERG PRINCIPLE

FACTORS AFFECTING HARDY-WEINBERG EQUILIBRIUM

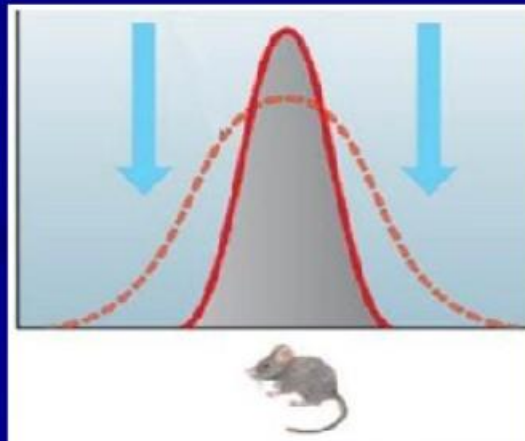
5

NATURAL SELECTION

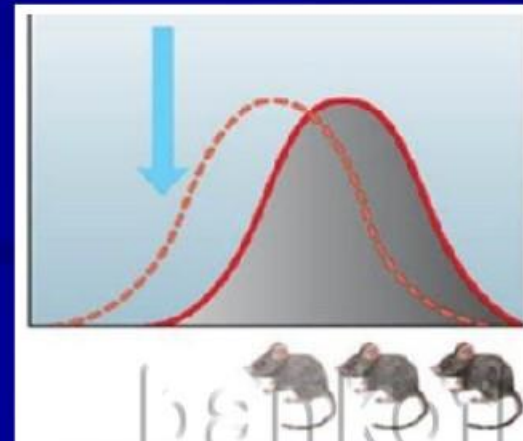


3 types of natural selection

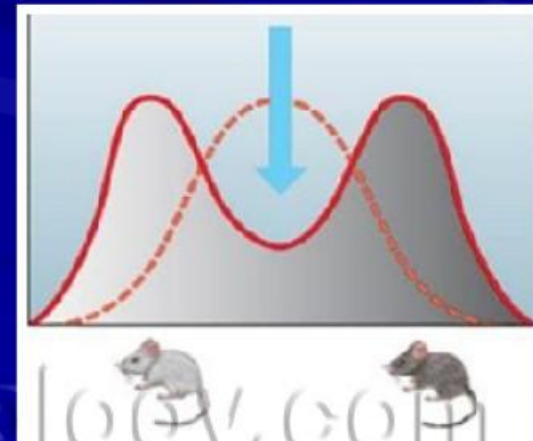
Stabilizing
selection



Directional
selection



Disruptive
selection

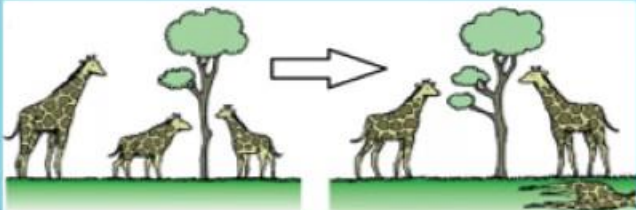


HARDY- WEINBERG PRINCIPLE

FACTORS AFFECTING HARDY-WEINBERG EQUILIBRIUM

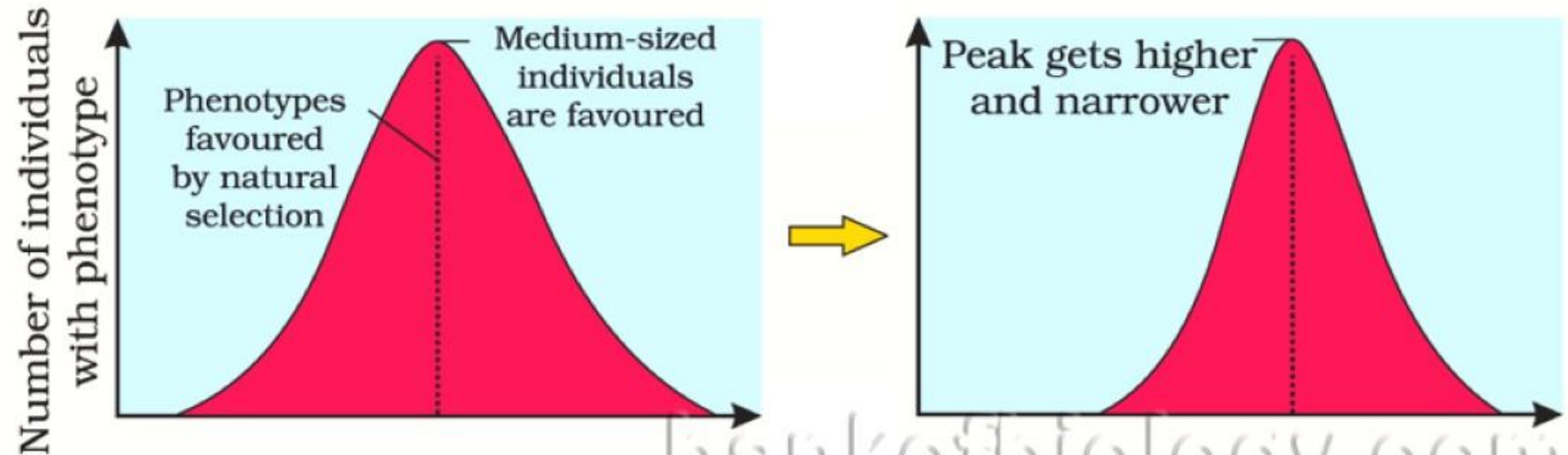
5

NATURAL SELECTION



1. Stabilizing selection

- Here, more individuals acquire mean character value and variation is reduced. bankofbiology.com

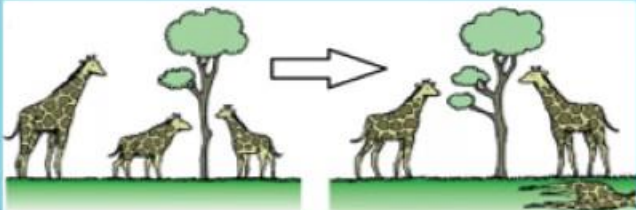


HARDY-WEINBERG PRINCIPLE

FACTORS AFFECTING HARDY-WEINBERG EQUILIBRIUM

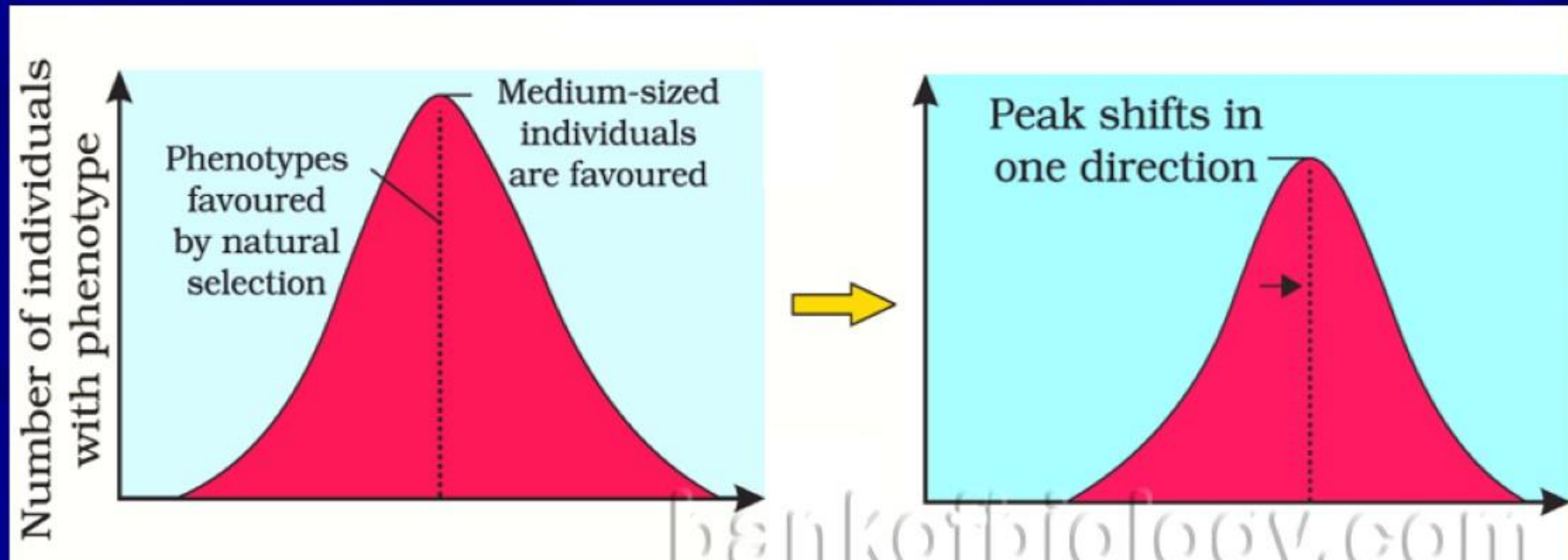
5

NATURAL SELECTION



2. Directional selection

- Here, Individuals of one extreme (value other than mean character value) are more favoured.

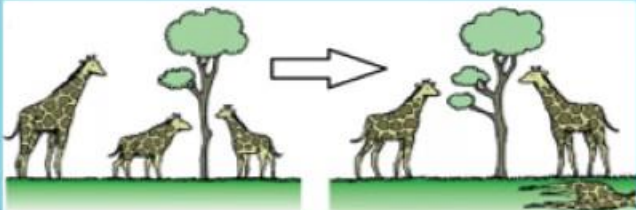


HARDY- WEINBERG PRINCIPLE

FACTORS AFFECTING HARDY-WEINBERG EQUILIBRIUM

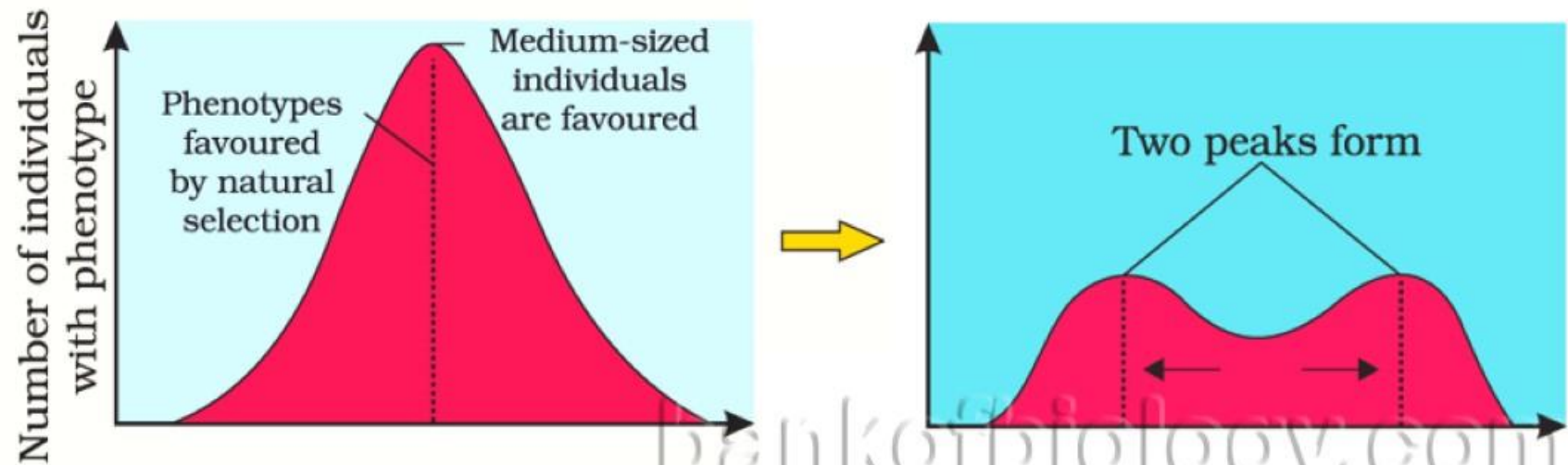
5

NATURAL SELECTION



3. Disruptive selection

- Here, Individuals of both extremes (peripheral character value at both ends of the distribution curve) are more favoured.

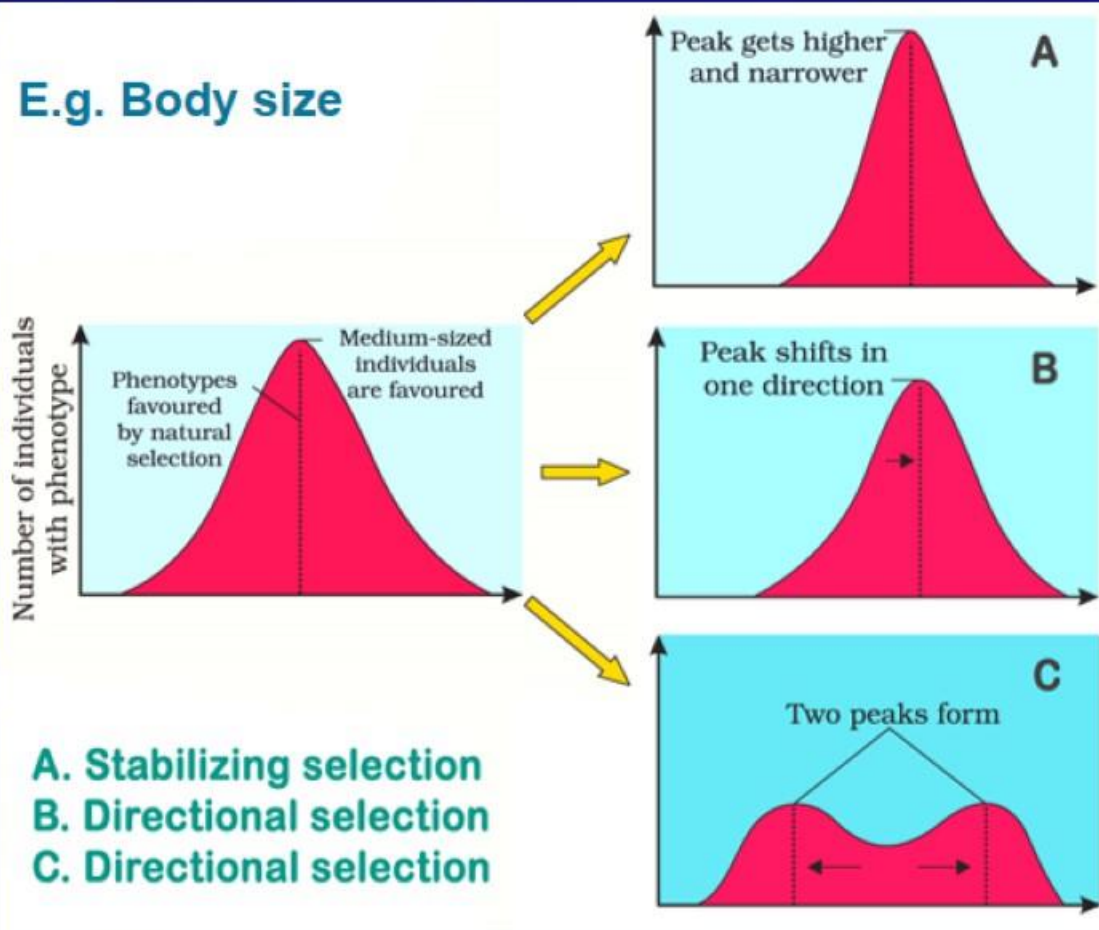


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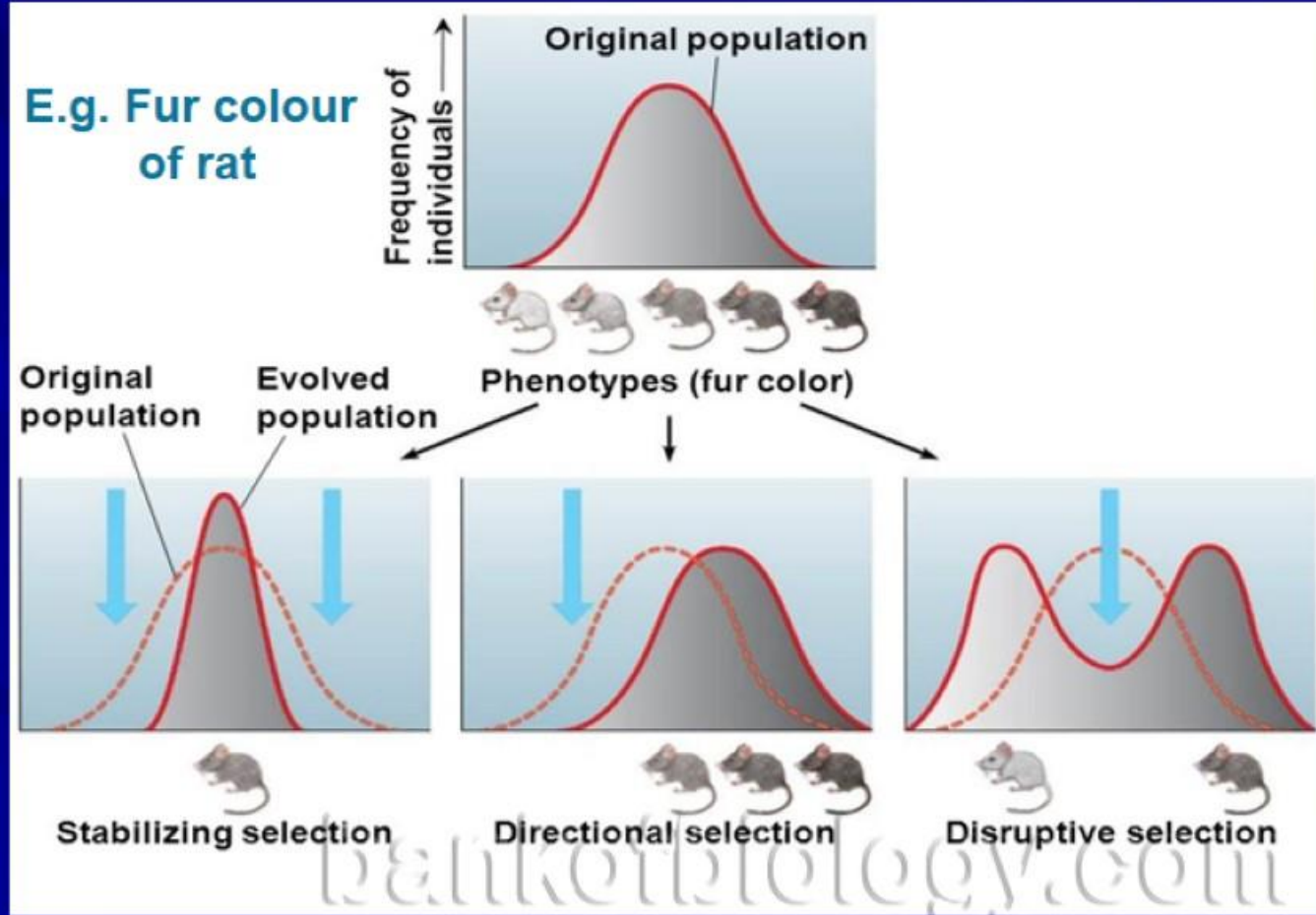
FACTORS AFFECTING HARDY-WEINBERG EQUILIBRIUM

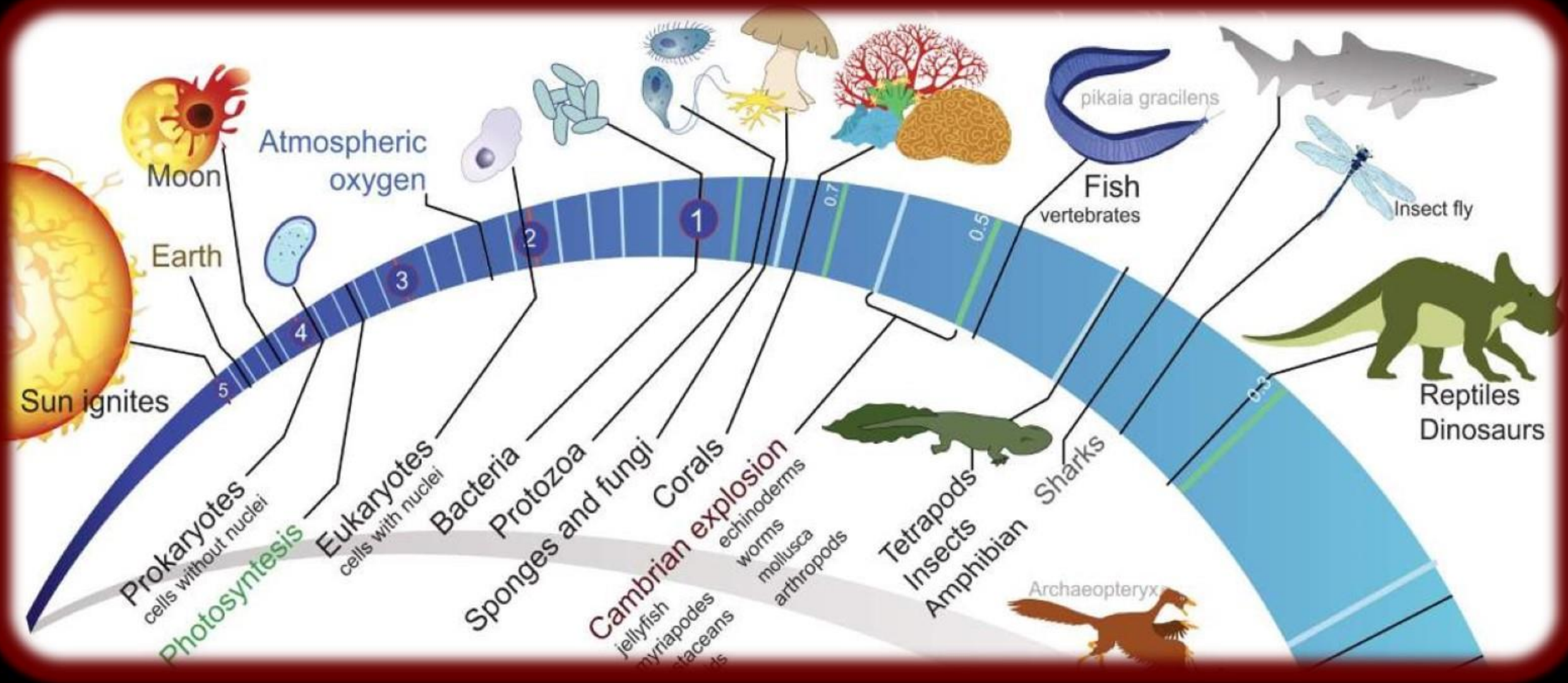
Natural selection

E.g. Body size



E.g. Fur colour of rat



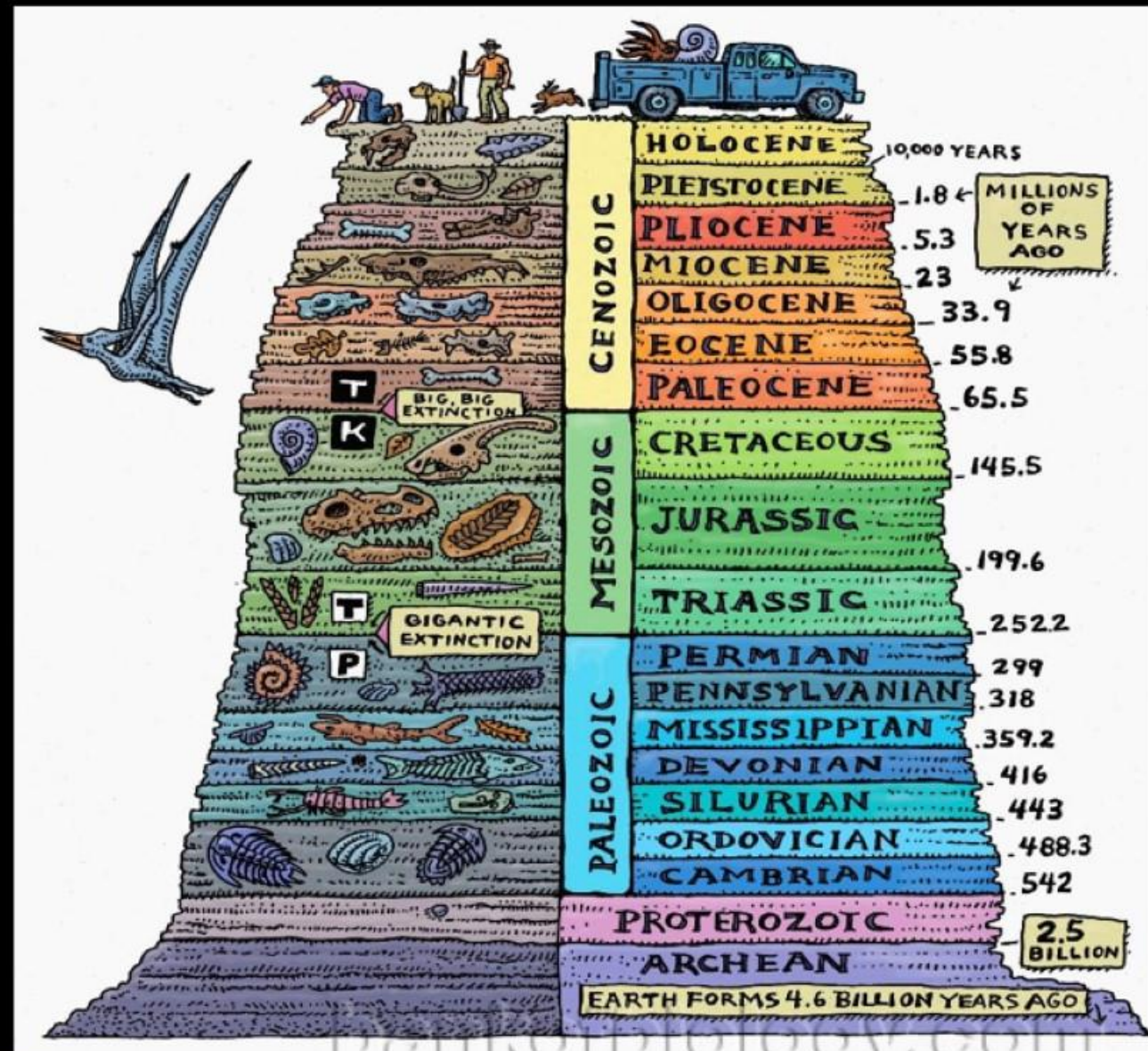


A BRIEF ACCOUNT OF EVOLUTION

A BRIEF ACCOUNT OF EVOLUTION

The geological time scale includes 4 eras:

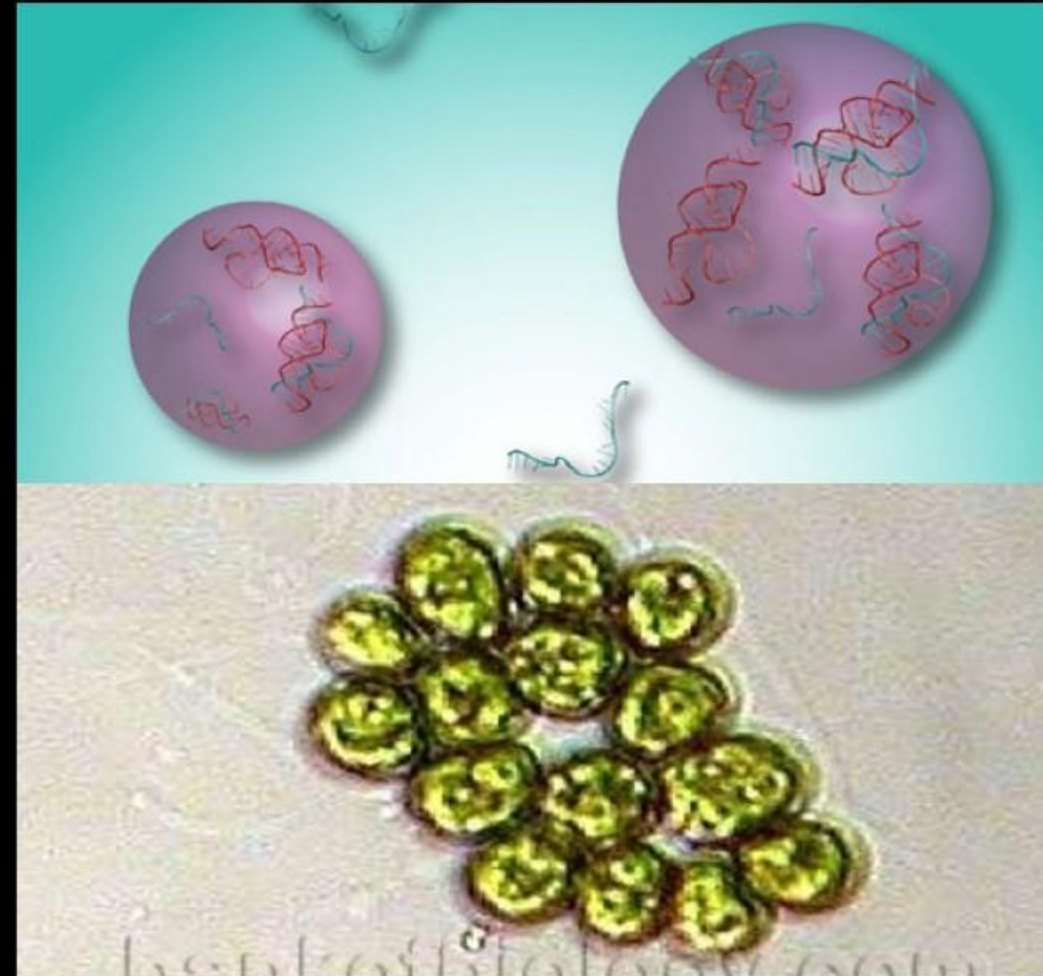
- ❖ Proterozoic
- ❖ Palaeozoic
- ❖ Mesozoic
- ❖ Cenozoic



A BRIEF ACCOUNT OF **EVOLUTION**

PROTEROZOIC ERA (2500 – 541 mya)

- ▶ First cellular forms of life appeared (2000 mya).
- ▶ Some of the cells had the ability to release O_2 as the light reaction in photosynthesis.
- ▶ Single celled organisms became Multicellular organisms.

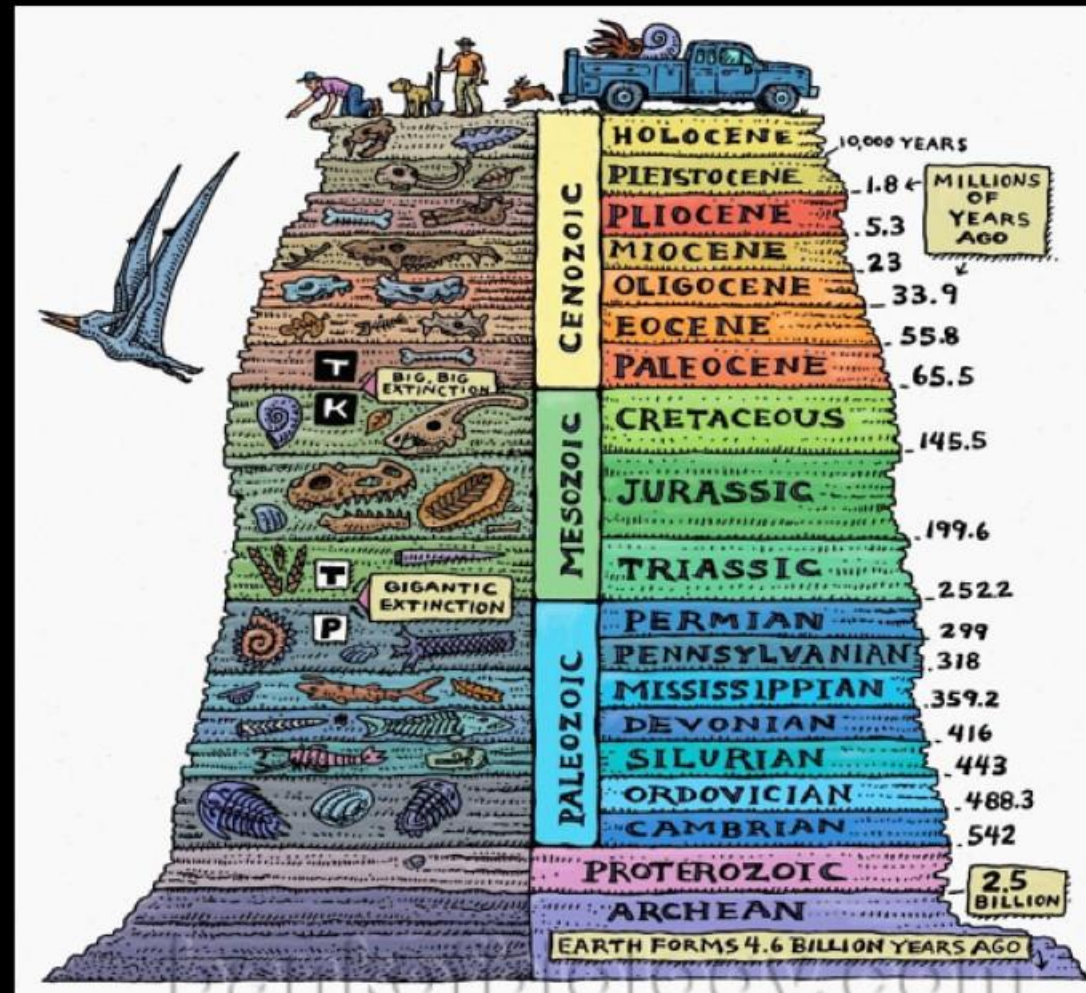


A BRIEF ACCOUNT OF **EVOLUTION**

PALEOZOIC ERA (540 – 252 mya)

It has 6 periods:

- ▶ **Cambrian** (540 - 490 mya)
- ▶ **Ordovician** (490 - 443 mya)
- ▶ **Silurian** (425 mya)
- ▶ **Devonian** (405 mya)
- ▶ **Carboniferous** (360 mya)
- ▶ **Permian** (285 mya)



A BRIEF ACCOUNT OF **EVOLUTION**

PALEOZOIC ERA (540 – 252 mya)

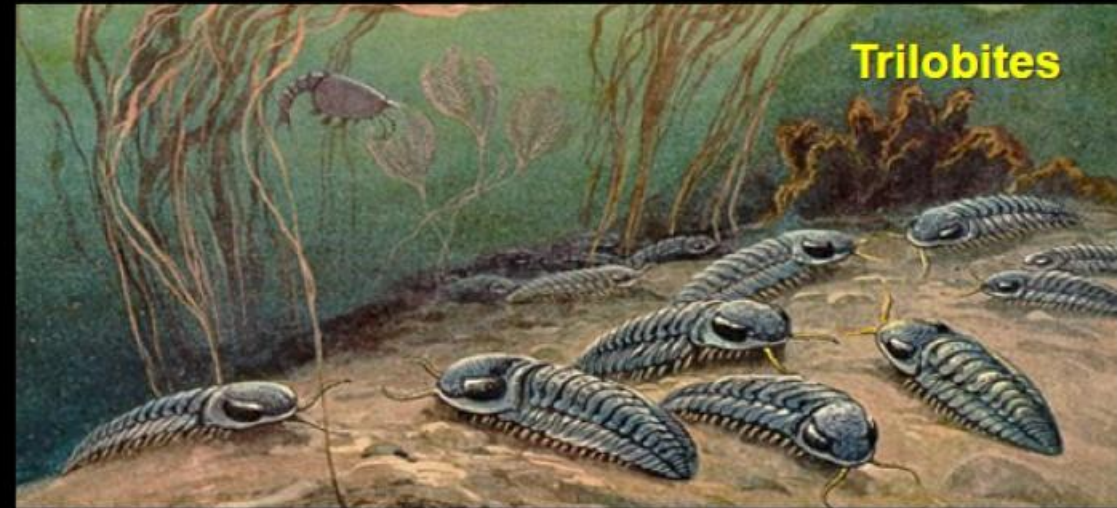
- ▶ **500 mya:** Invertebrates were formed.
- ▶ **450 mya:** First land organisms (plants) appeared.



A BRIEF ACCOUNT OF **EVOLUTION**

PALEOZOIC ERA (540 – 252 mya)

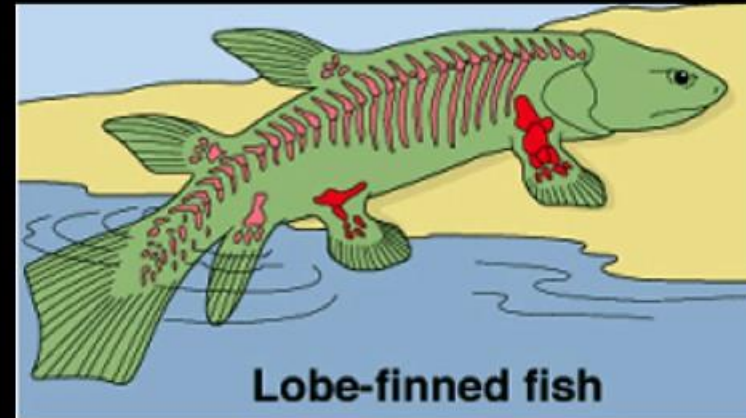
- ▶ **500 mya:** Invertebrates were formed.
- ▶ **450 mya:** First land organisms (plants) appeared.
- ▶ **400 mya:** Arthropods invaded the land.
- ▶ **350 mya:** Jawless fishes were evolved.



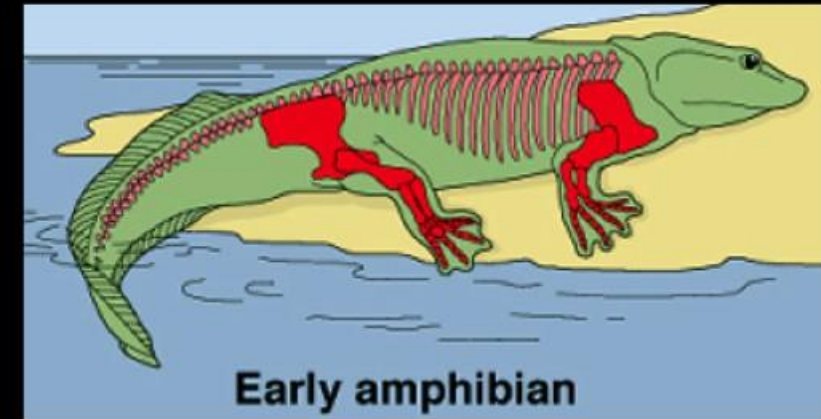
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- Lobefins** (stout & strong finned fishes) could move on land and go back to water. They evolved to first amphibians (ancestors of modern day frogs & salamanders).



Lobe-finned fish



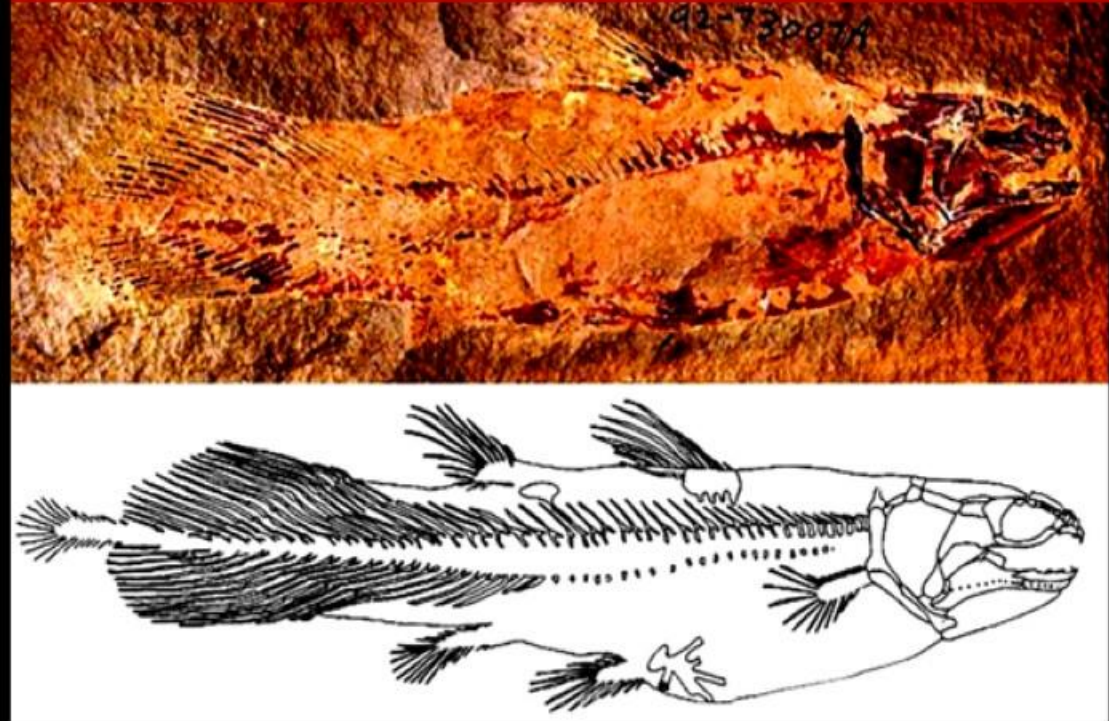
Early amphibian

A BRIEF ACCOUNT OF EVOLUTION

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Fossil of Coelacanth (A lobefin fish)



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The “325 million year old” lobe-fin coelacanth is still very much alive.

In 1938, a lobe-fin called **coelacanth fish** was caught in South Africa which was thought to be extinct. bankofbiology.com

A BRIEF ACCOUNT OF EVOLUTION

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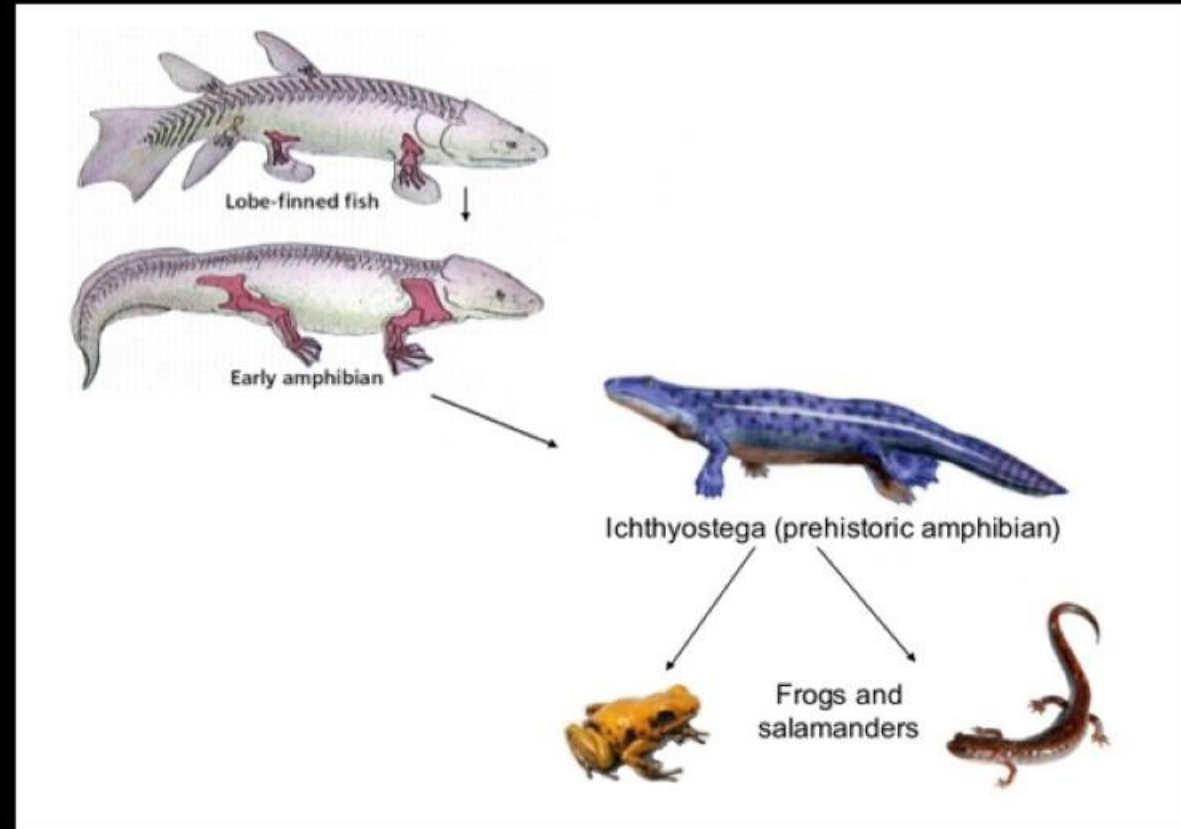


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 - ▶ **400 mya:** Arthropods invaded the land.
 - ▶ **350 mya:** Jawless fishes were evolved.
- Lobefins** (stout & strong finned fishes) could move on land and go back to water. They evolved to first amphibians (ancestors of modern day frogs & salamanders).



In 1938, a lobe-fin called **coelacanth fish** was caught in South Africa which was thought to be extinct. bankofbiology.com

A BRIEF ACCOUNT OF EVOLUTION

PALEOZOIC ERA (540 – 252 mya)

- ▶ **320 mya:** Sea weeds and few plants were existed.
- ▶ Amphibians evolved to reptiles. They lay thick-shelled eggs (do not dry up in sun).
- ▶ Giant ferns (Pteridophytes) were present but they all fell to form coal deposits slowly.



A BRIEF ACCOUNT OF **EVOLUTION**

MESOZOIC ERA (252 – 66 mya)

- ▶ Age of reptiles & gymnosperms.
- ▶ It has 3 periods:
 - ❖ **Triassic (230 mya)**
 - ❖ **Jurassic (208 mya)**
 - ❖ **Cretaceous (144 mya)**



A BRIEF ACCOUNT OF **EVOLUTION**

MESOZOIC ERA (252 – 66 mya)

- ▶ **200 mya:** Some of the land reptiles went back into water to evolve into fish-like reptiles (E.g. *Ichthyosaurs*).



Ichthyosaurs

A BRIEF ACCOUNT OF EVOLUTION

MESOZOIC ERA (252 – 66 mya)

- ▶ **200 mya:** Some of the land reptiles went back into water to evolve into fish-like reptiles (E.g. *Ichthyosaurs*).
- ▶ The land reptiles were **dinosaurs**. (*Tyrannosaurus rex*, *Triceratops*, *Stegosaurus*, *Brachiosaurus* etc.).

Tyrannosaurus rex



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Triceratops

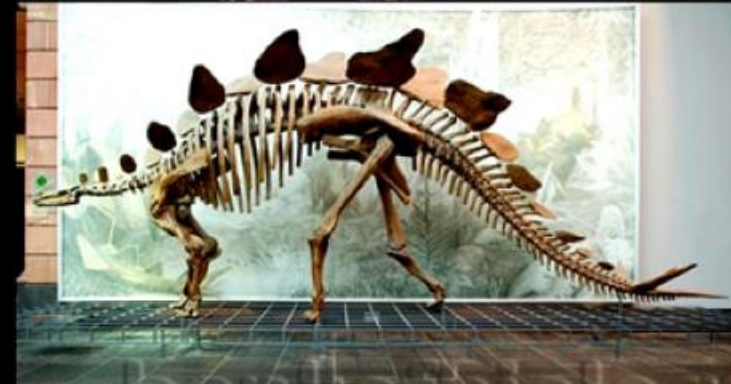
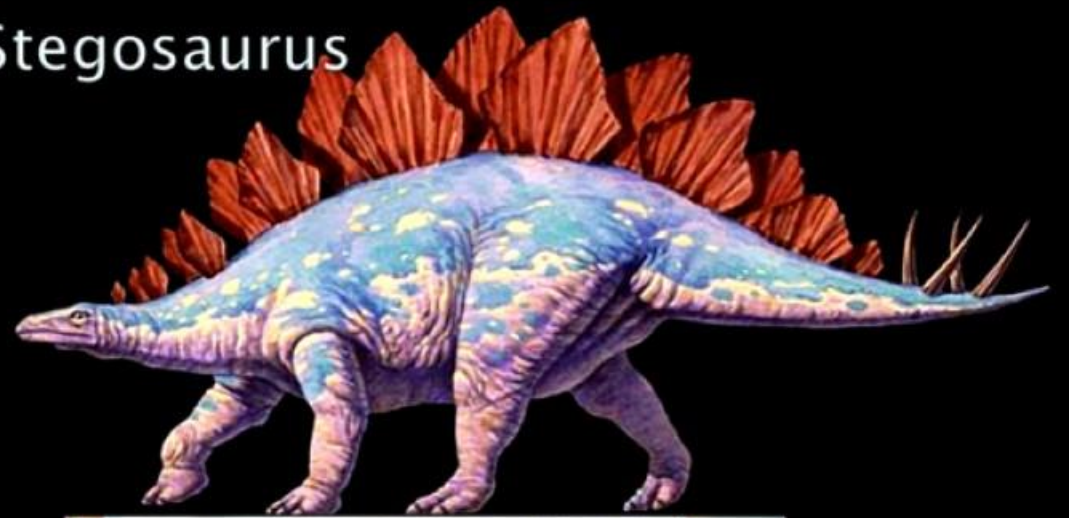


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Stegosaurus



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BRACHIOSAURUS



A BRIEF ACCOUNT OF EVOLUTION

MESOZOIC ERA (252 – 66 mya)

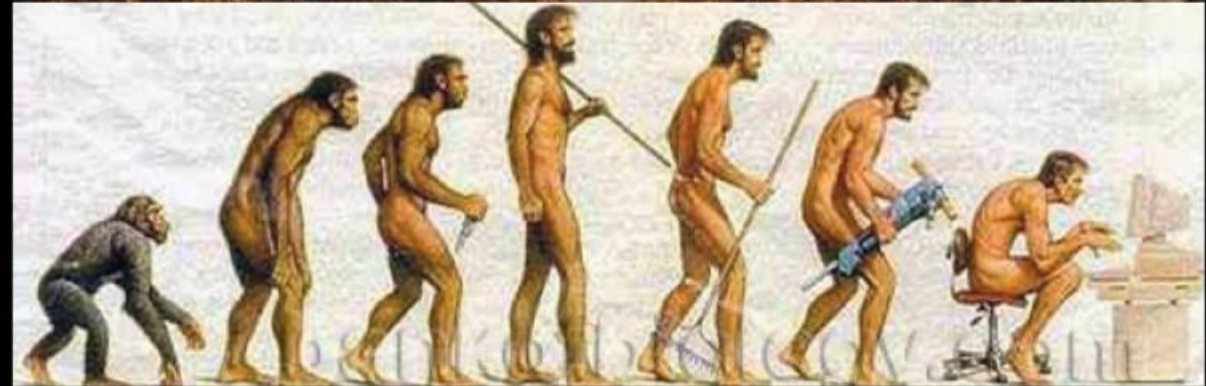
- ▶ **200 mya:** Some of the land reptiles went back into water to evolve into fish-like reptiles (E.g. *Ichthyosaurs*).
- ▶ The land reptiles were **dinosaurs**. (*Tyrannosaurus rex*, *Triceratops*, *Stegosaurus*, *Brachiosaurus* etc.).
- ▶ *T. rex* was the largest dinosaur (20 feet in height, huge fearsome dagger-like teeth).
- ▶ Toothed birds were emerged.



A BRIEF ACCOUNT OF **EVOLUTION**

COENOZOIC ERA (66 – 0 mya)

- ▶ Age of Mammals & Angiosperms.
- ▶ It has 2 periods:
 - ❖ Tertiary (66 mya)
 - ❖ Quaternary (2 mya - Age of man).



A BRIEF ACCOUNT OF EVOLUTION

COENOZOIC ERA (66 – 0 mya)

- ▶ **65 mya:** Dinosaurs suddenly disappeared. Some say climatic changes killed them. Some say most of them evolved into birds.



A BRIEF ACCOUNT OF **EVOLUTION**

COENOZOIC ERA (66 – 0 mya)

- ▶ **65 mya:** Dinosaurs suddenly disappeared. Some say climatic changes killed them. Some say most of them evolved into birds.
- ▶ First mammals were shrew-like. Their fossils are small sized.



A BRIEF ACCOUNT OF **EVOLUTION**

COENOZOIC ERA (66 – 0 mya)

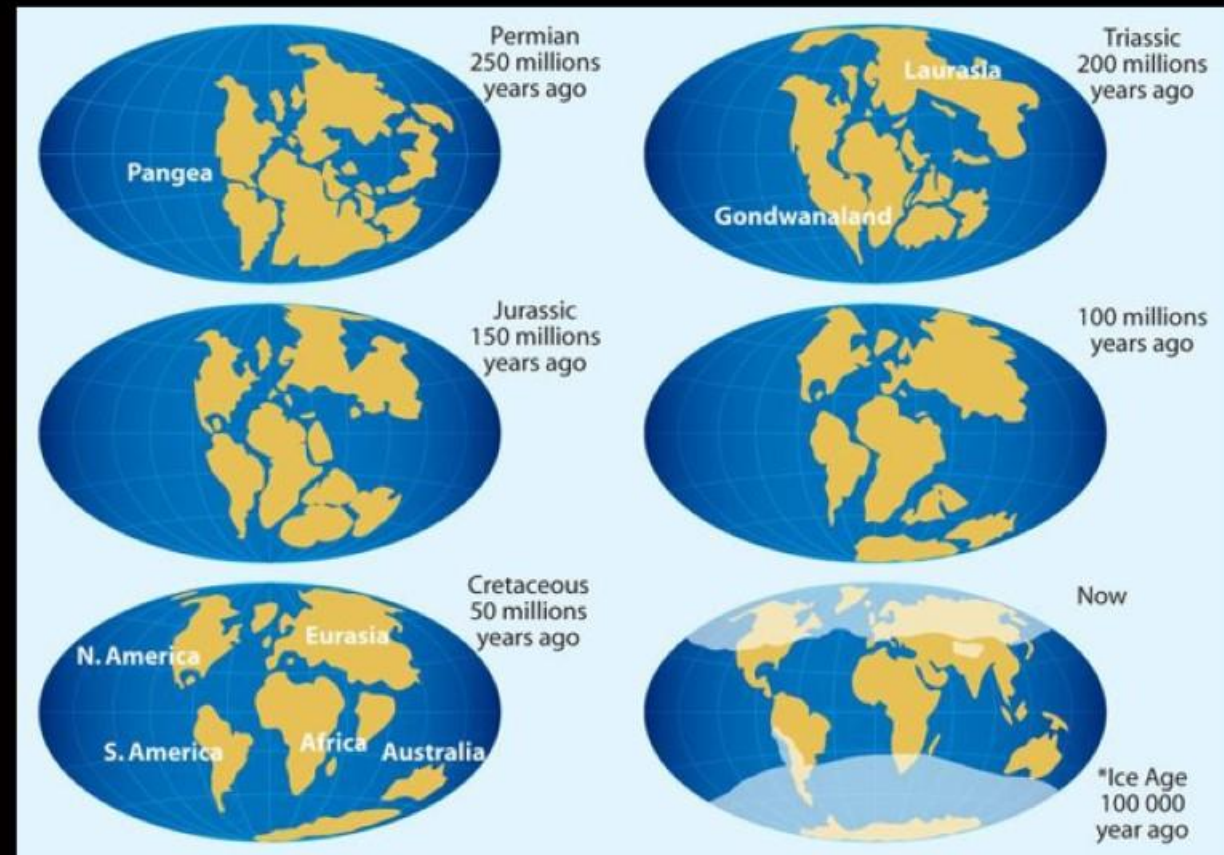
- ▶ In South America, there were mammals resembling horse, hippopotamus, bear, rabbit etc.
- ▶ Due to continental drift, when South America joined North America, these animals were overridden by North American fauna.



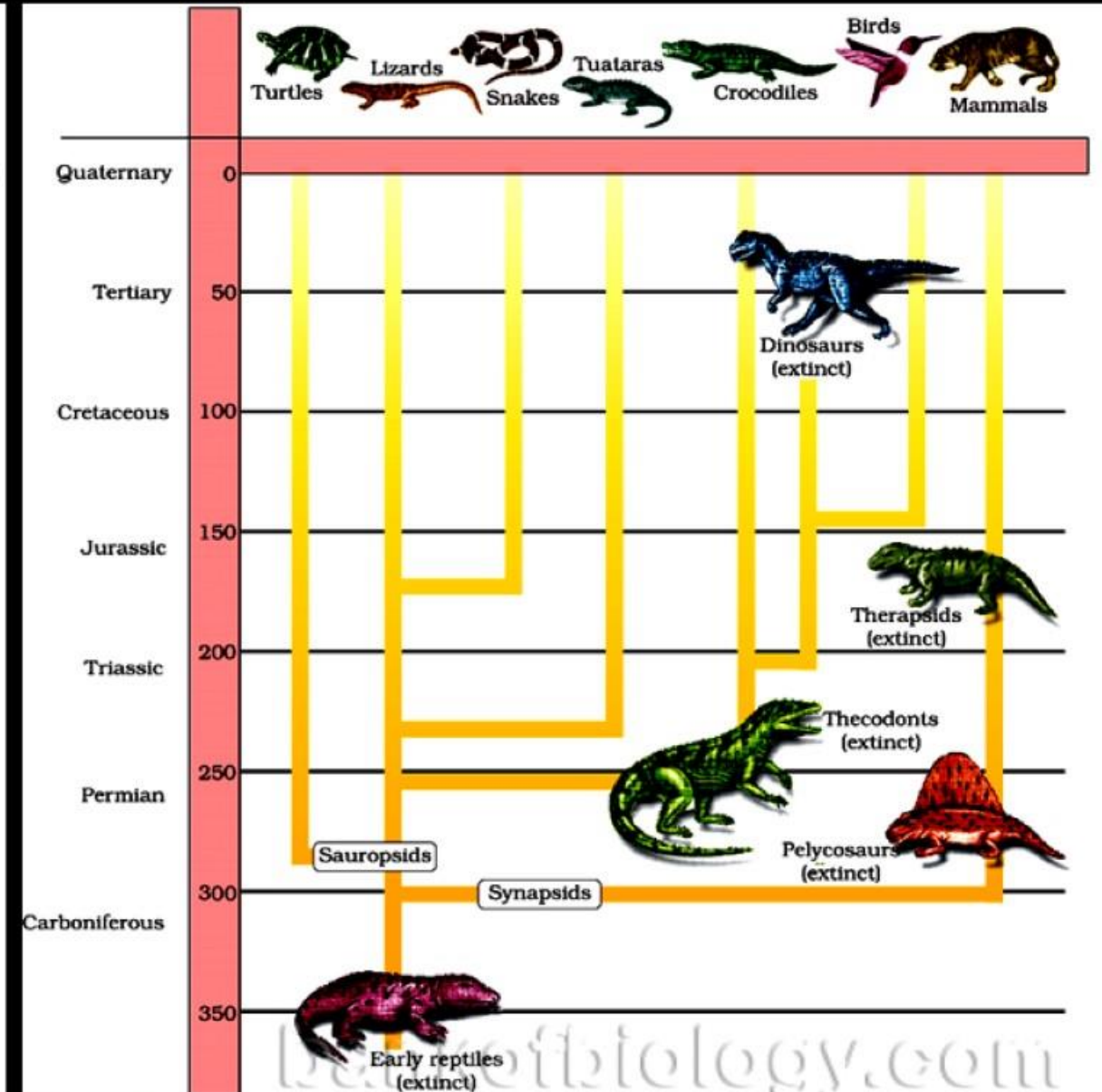
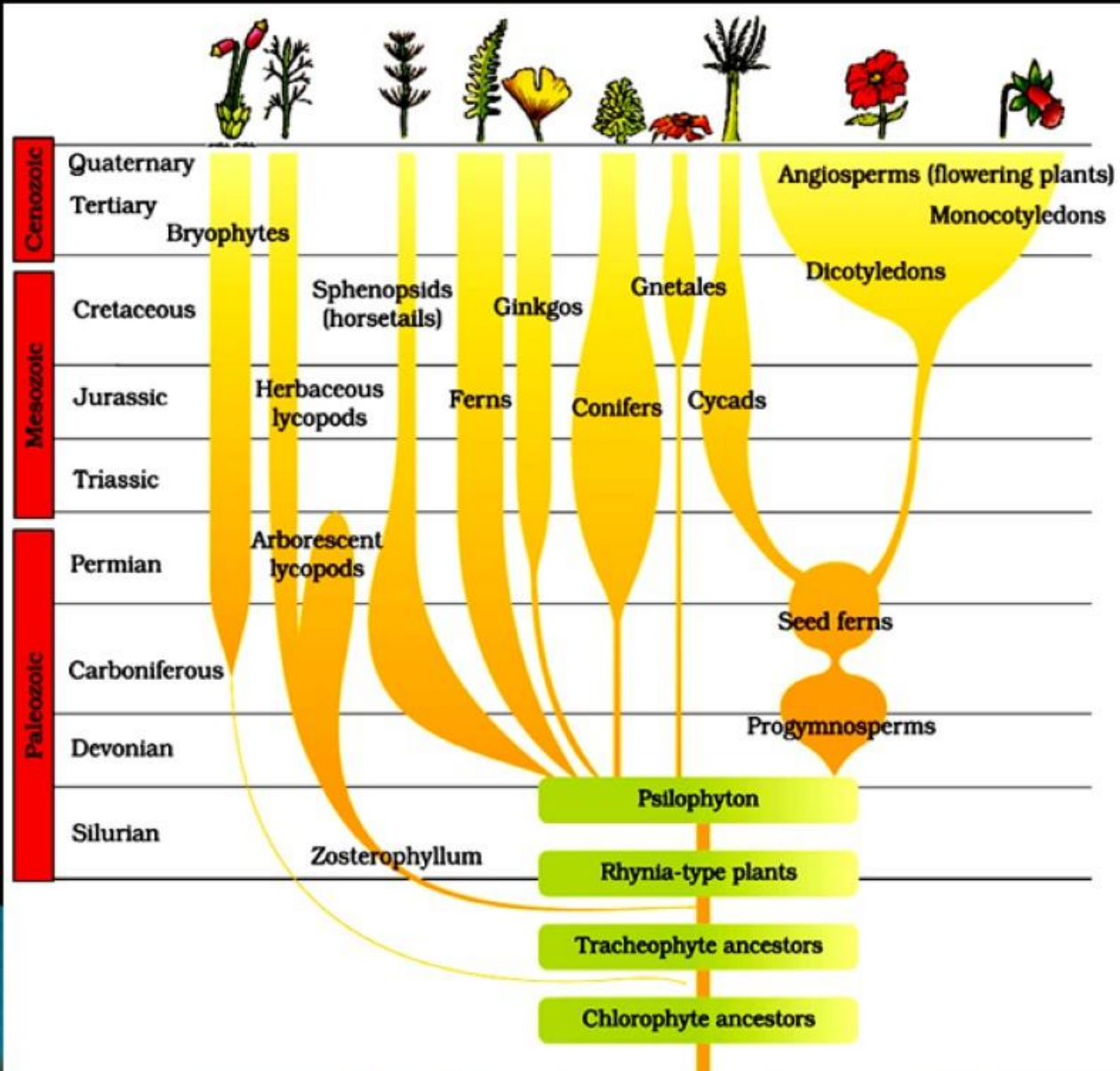
A BRIEF ACCOUNT OF EVOLUTION

COENOZOIC ERA (66 – 0 mya)

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- ▶ Due to continental drift, when South America joined North America, these animals were overridden by North American fauna.
- ▶ Due to continental drift, **Australian Marsupials** survived because of lack of competition from any other mammals.

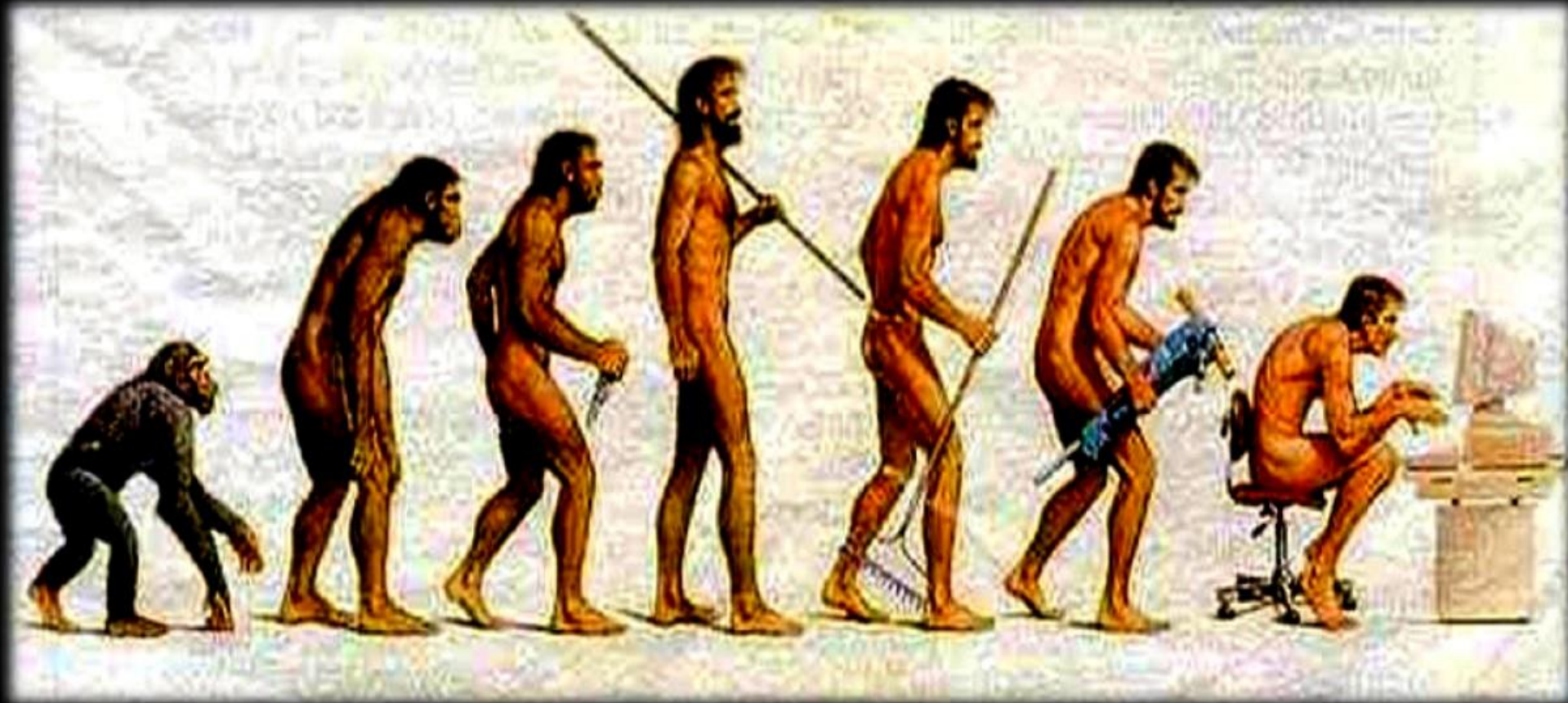


A BRIEF ACCOUNT OF EVOLUTION



A BRIEF ACCOUNT OF EVOLUTION

ORIGIN AND EVOLUTION OF MAN



A BRIEF ACCOUNT OF EVOLUTION

ORIGIN AND EVOLUTION OF MAN

DRYOPITHECUS & RAMAPITHECUS

- ▶ 15 mya.
- ▶ Hairy.
- ▶ Walked like gorillas and chimpanzee.
- ▶ **Dryopithecus**: More ape-like.
- ▶ **Ramapithecus**: More man-like.



Dryopithecus



Ramapithecus

A BRIEF ACCOUNT OF EVOLUTION

ORIGIN AND EVOLUTION OF MAN

- ▶ **3-4 mya**, there were man-like primates in eastern Africa.
- ▶ They had height up to 4 feet and walked up right.
- ▶ This belief is based on fossils of man-like bones found in Ethiopia & Tanzania.

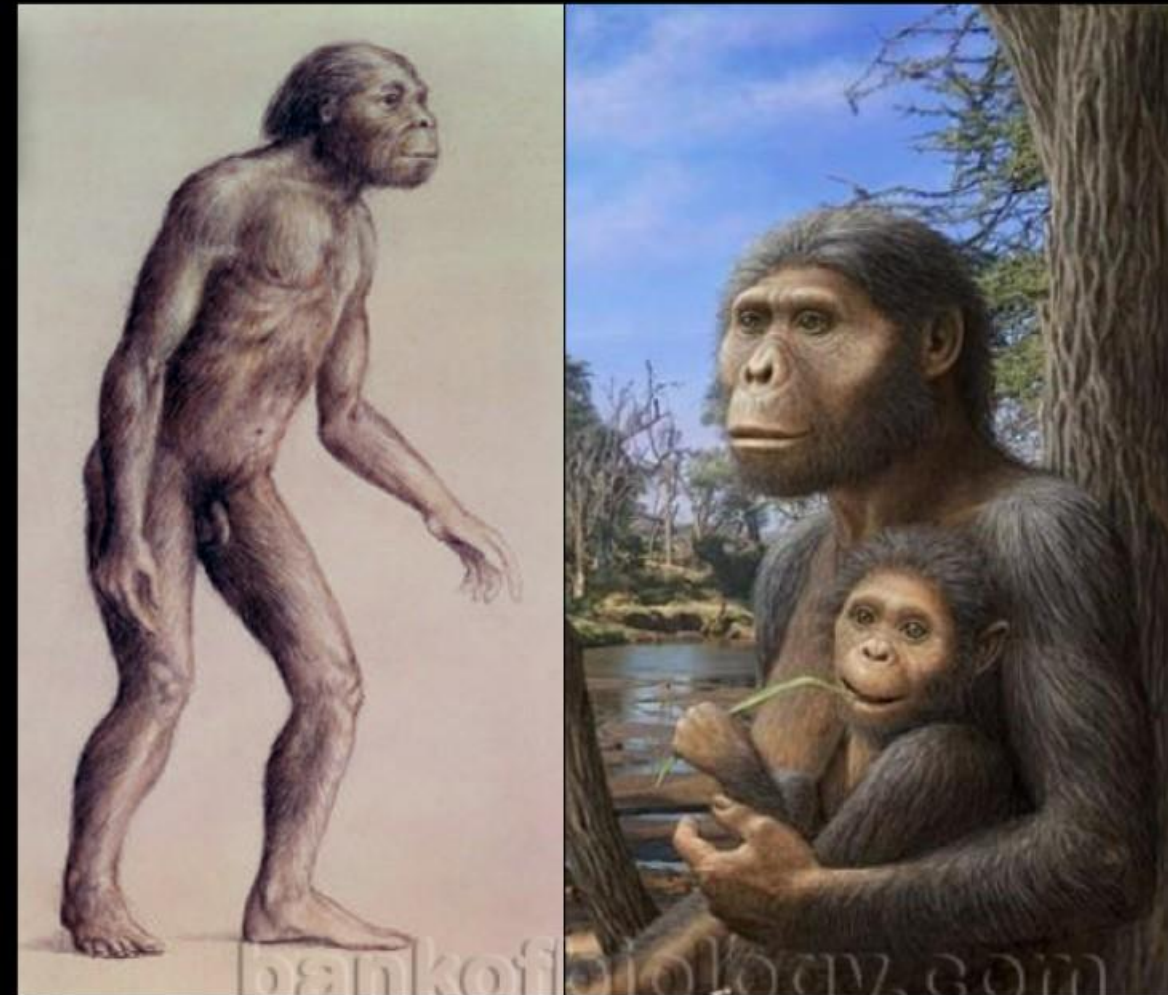


A BRIEF ACCOUNT OF **EVOLUTION**

ORIGIN AND EVOLUTION OF MAN

AUSTRALOPITHECUS

- ▶ **2 mya.**
- ▶ **Lived in East African grass lands.**
- ▶ **Hunted with stone weapons.**
- ▶ **Ate fruits.**

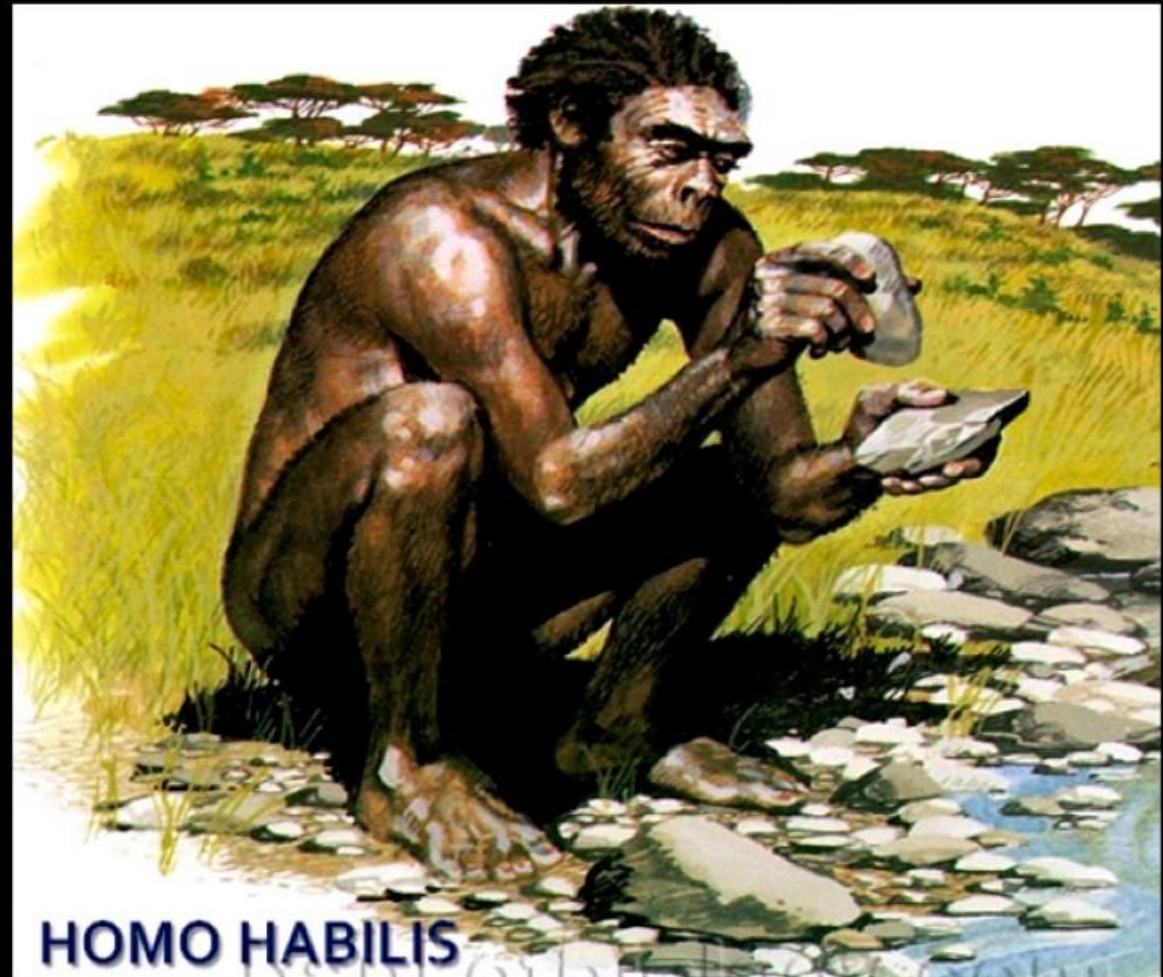


A BRIEF ACCOUNT OF **EVOLUTION**

ORIGIN AND EVOLUTION OF MAN

HOMO HABILIS

- ▶ 2 mya.
- ▶ First human-like being (hominid).
- ▶ Brain capacity: 650-800 cc.
- ▶ Did not eat meat.

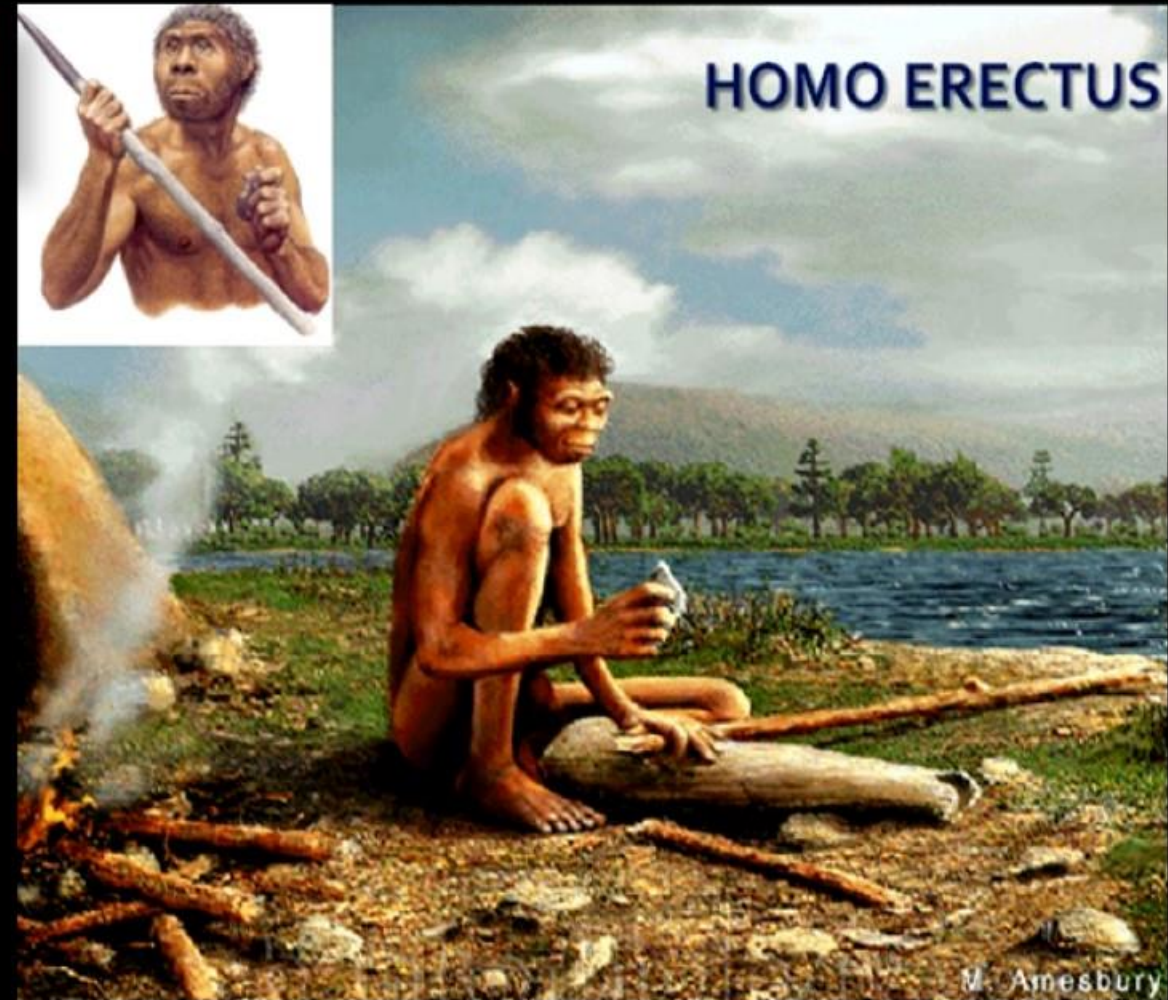
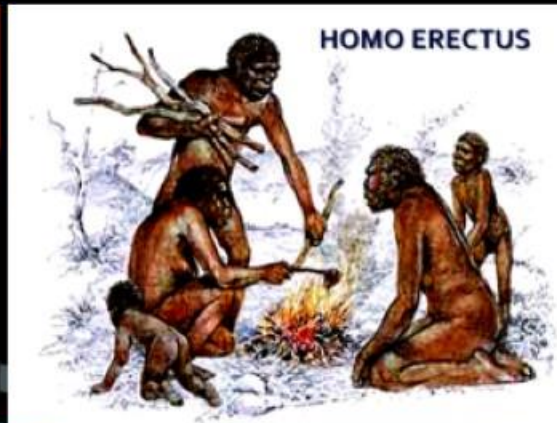


A BRIEF ACCOUNT OF EVOLUTION

ORIGIN AND EVOLUTION OF MAN

HOMO ERECTUS

- ▶ 1.5 mya.
- ▶ Brain capacity: 900 cc.
- ▶ Ate meat.



A BRIEF ACCOUNT OF EVOLUTION

ORIGIN AND EVOLUTION OF MAN

HOMO NEANDERTHALENSIS (NEANDERTHAL MAN)

- ▶ 1 lakh - 40,000 years ago.
- ▶ Brain capacity: 1400 cc.
- ▶ Lived in East and Central Asia.
- ▶ Used hides to protect their body.
- ▶ Buried their dead.

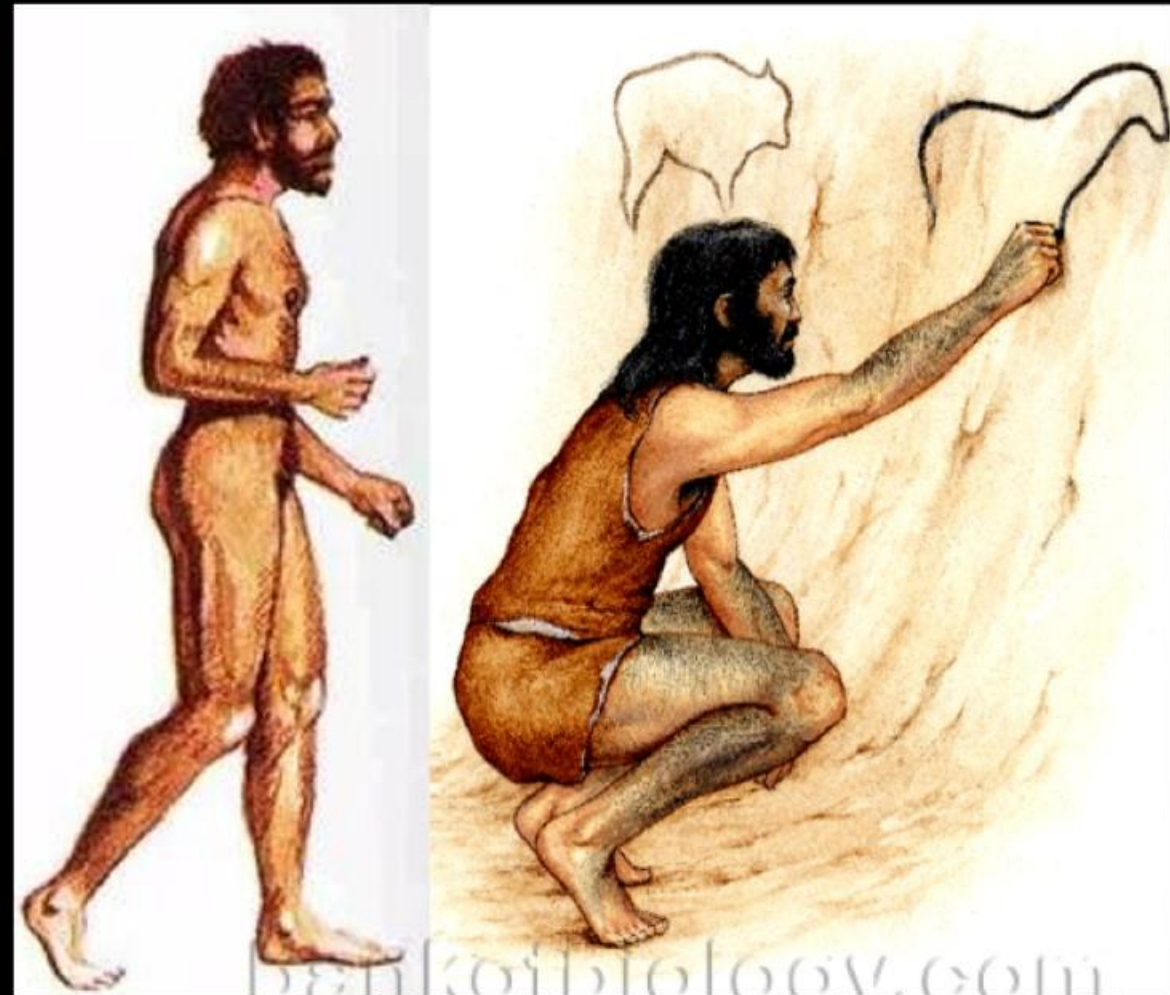


A BRIEF ACCOUNT OF EVOLUTION

ORIGIN AND EVOLUTION OF MAN

HOMO SAPIENS (MODERN MAN)

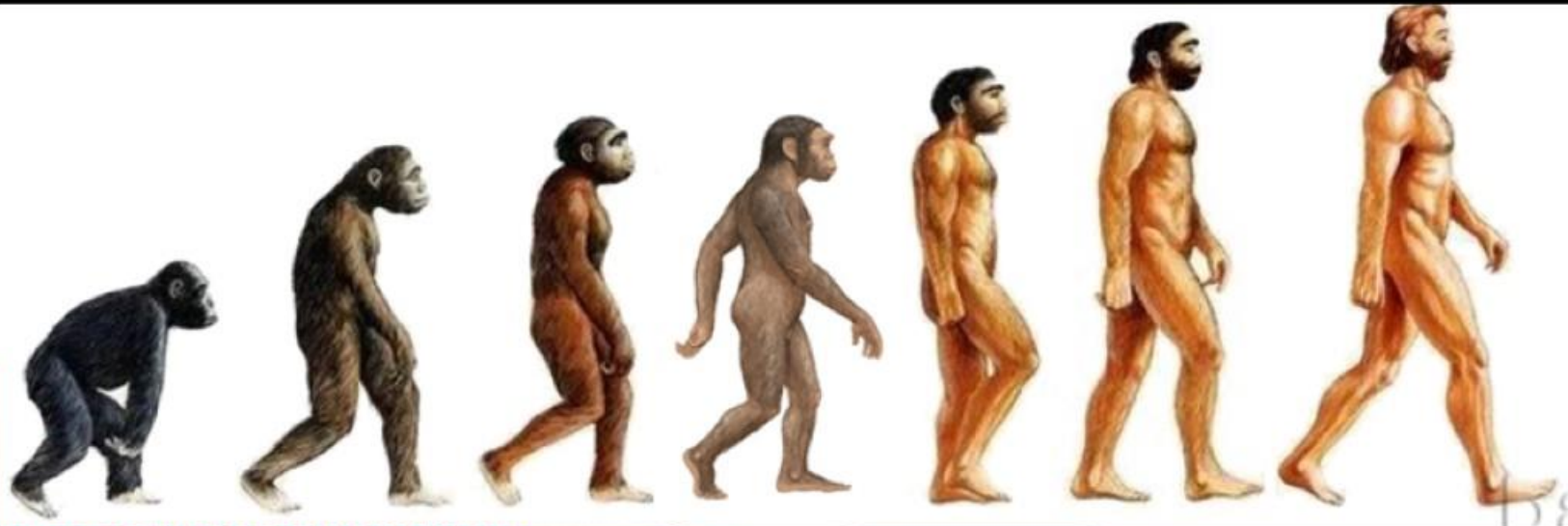
- ▶ 75,000 to 10,000 years ago (Ice age).
- ▶ Pre-historic cave art developed about 18,000 years ago.
- ▶ Agriculture and human settlements: 10,000 years ago.



A BRIEF ACCOUNT OF EVOLUTION

ORIGIN AND EVOLUTION OF MAN

SEQUENCE OF HUMAN EVOLUTION



Dryopithecus



Ramapithecus



Australopithecus



Homo habilis



Homo erectus



Homo neanderthalensis

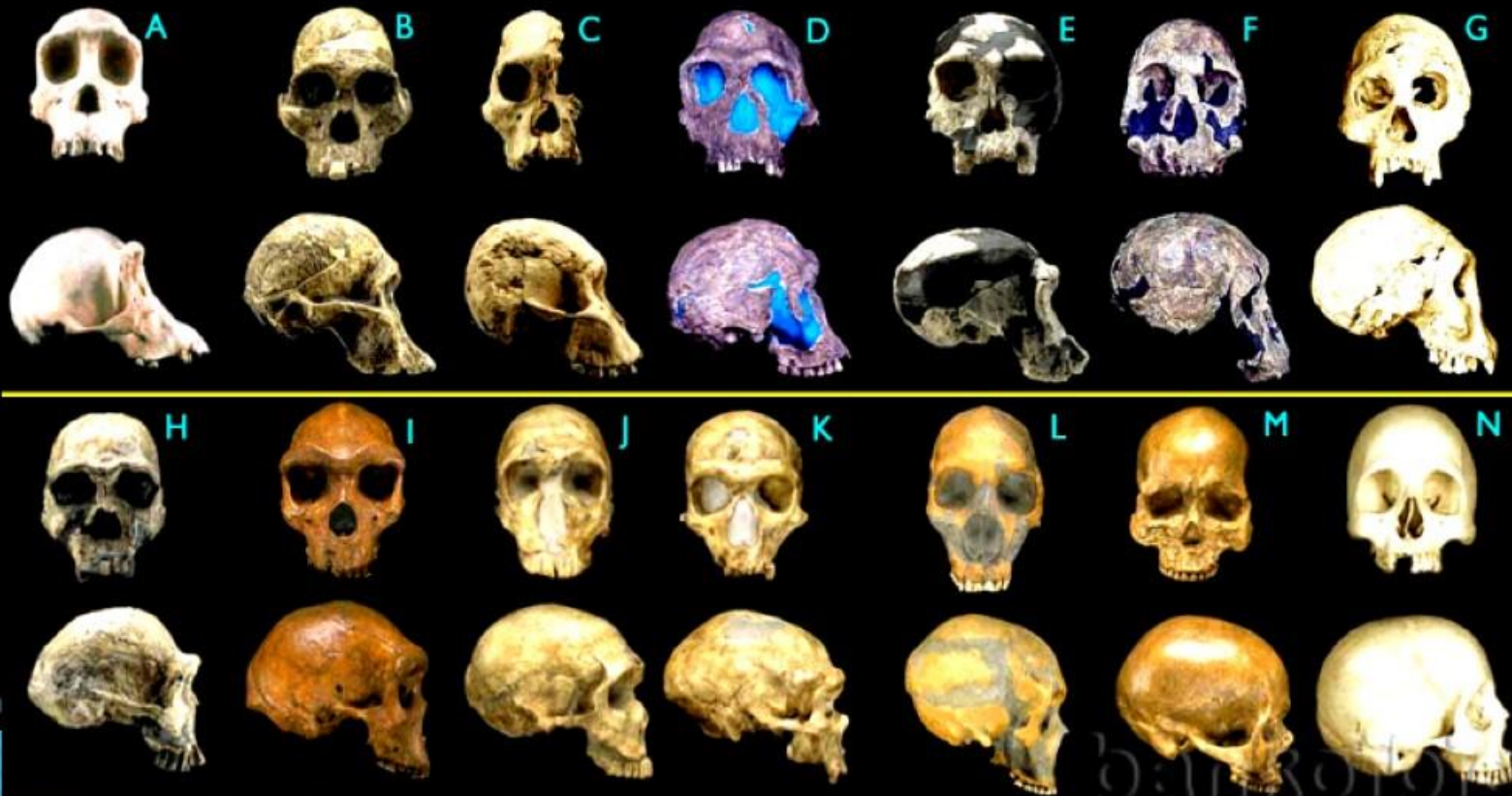


Homo sapiens

A BRIEF ACCOUNT OF EVOLUTION

ORIGIN AND EVOLUTION OF MAN

HOMINID FAMILY



A BRIEF ACCOUNT OF EVOLUTION

ORIGIN AND EVOLUTION OF MAN

A comparison of the skulls of

- a. **Adult modern human being**
- b. **Baby chimpanzee**
- c. **Adult chimpanzee**

The skull of baby chimpanzee is more like adult human skull than adult chimpanzee skull.

