

EVOLUTION



GAUTENG
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

Growing Gauteng Together

By M.S. 0042331758

EVOLUTION

- **Introduction (content of this slide)**
- Definition of biological evolution
- Difference between a hypothesis and a theory

EVIDENCE FOR EVOLUTION

- Role of the following as evidence for evolution:
- **Fossil record** – Link to Grade 10
- **Biogeography** – Link to Grade 10
- **Modification by descent**
(homologous structures)
- **Genetics**
- **Embryology**

◆ Variation

- ◆ Definition of a biological species and a population
- ◆ **Causes of variation**
 - Meiosis
 1. Crossing-over
 2. Random arrangement of chromosomes
 - Mutations
 - Random fertilization
 - Random mating
- ◆ Continuous and discontinuous variation



By: M.Saidi 0848331738

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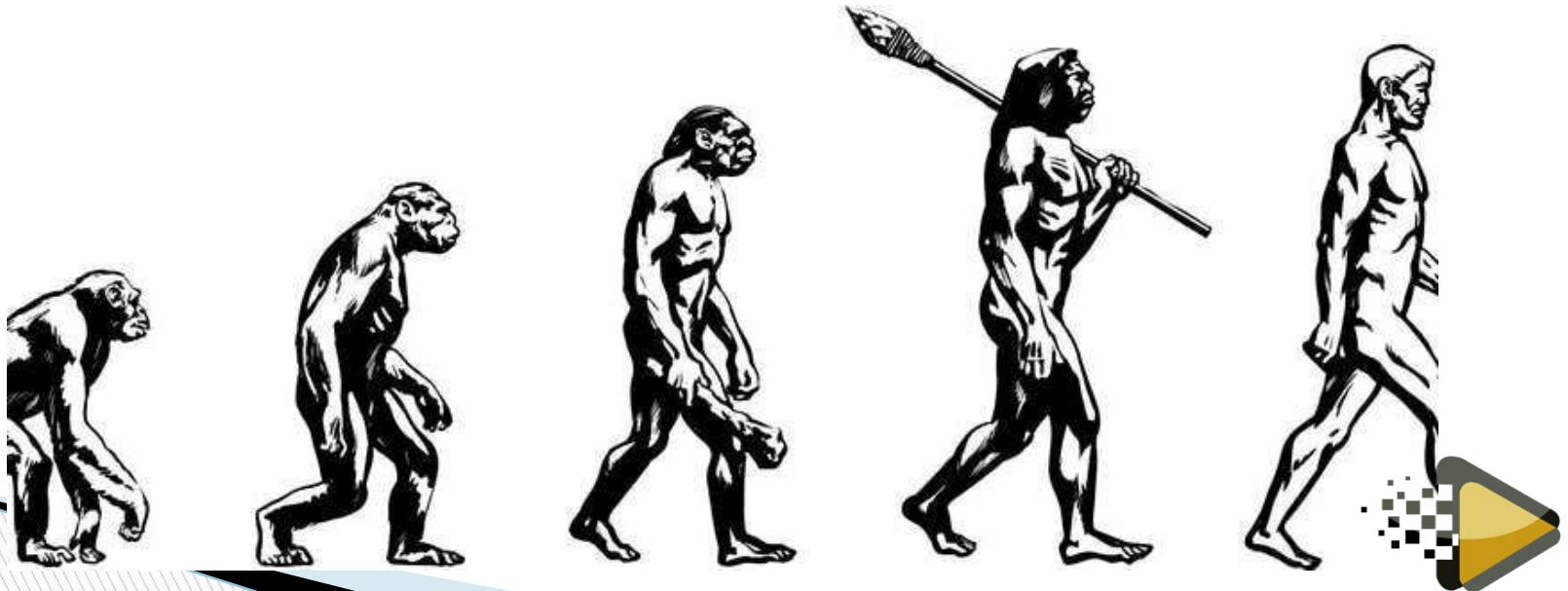
CONTENT : CLASS TIME

- **Evolution** is the **processes** of **change** in the **genes** that have transformed life on earth from its **earliest forms** to the vast **diversity** that characterizes life on earth today.
- Or **evolution** is the change in the **characteristics** of a species over **several generations** and relies on the process of **natural selection**.



□ **Biological Evolution** means **ALL** present-day forms of life

- have **descended from**, and are **related to**, those that lived in the past
- **Difference** may be because they became **modified** from one generation to another



By: M.Saidi 0848331738

HYPOTHESIS & THEORY

- **HYPOTHESIS** Is a **tentative explanation** for phenomena, facts, or a scientific inquiry that may **be tested**, verified or answered by further investigation
- You must be able to test your **hypothesis**, and it must be possible to prove your **hypothesis** true or false.



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- For **example**, Michael observes that maple trees lose their leaves in the fall.
 - He might then propose a possible explanation for this observation:
 - “cold weather causes maple trees to lose their leaves in the fall.”
- This statement is testable.



THEORY

- A scientific **theory** is a broad **explanation** for events that is widely **accepted as true**.
- To become a **theory**, a hypothesis must be tested over and over again, and it must be supported by a great deal of evidence.
eg
- the **theory** of evolution by natural selection. **Charles Darwin**
- People commonly use the word **theory** to describe a guess about how or why something happens



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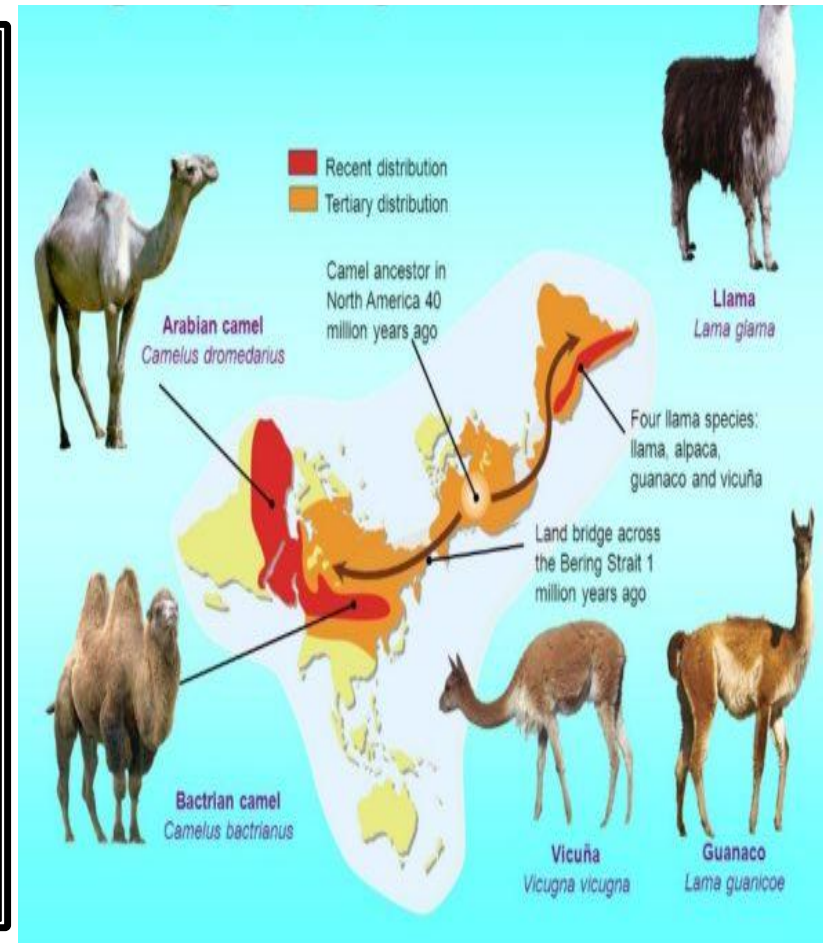
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EVIDENCE OF EVOLUTION

1. Biogeography

is the study of the **distribution** of **species** and **ecosystems** in geographic space and through geological time.

provides information about **how** and **when** species may have **evolved**..

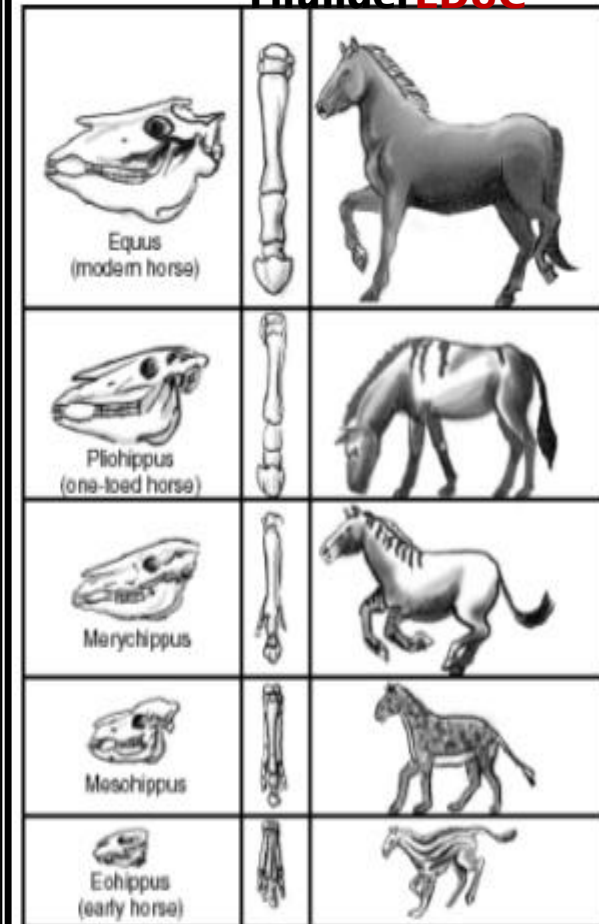


2. Fossil record

- ❑ **Fossil remains** have been found in rocks of all ages.
- ❑ **Fossils** of the **simplest** organisms are found in **the oldest rocks**, and **fossils** of more **complex organisms** in **the newest rocks**.
- ❑ This supports **Darwin's theory of evolution**, which states that simple life forms gradually evolved into more complex ones.



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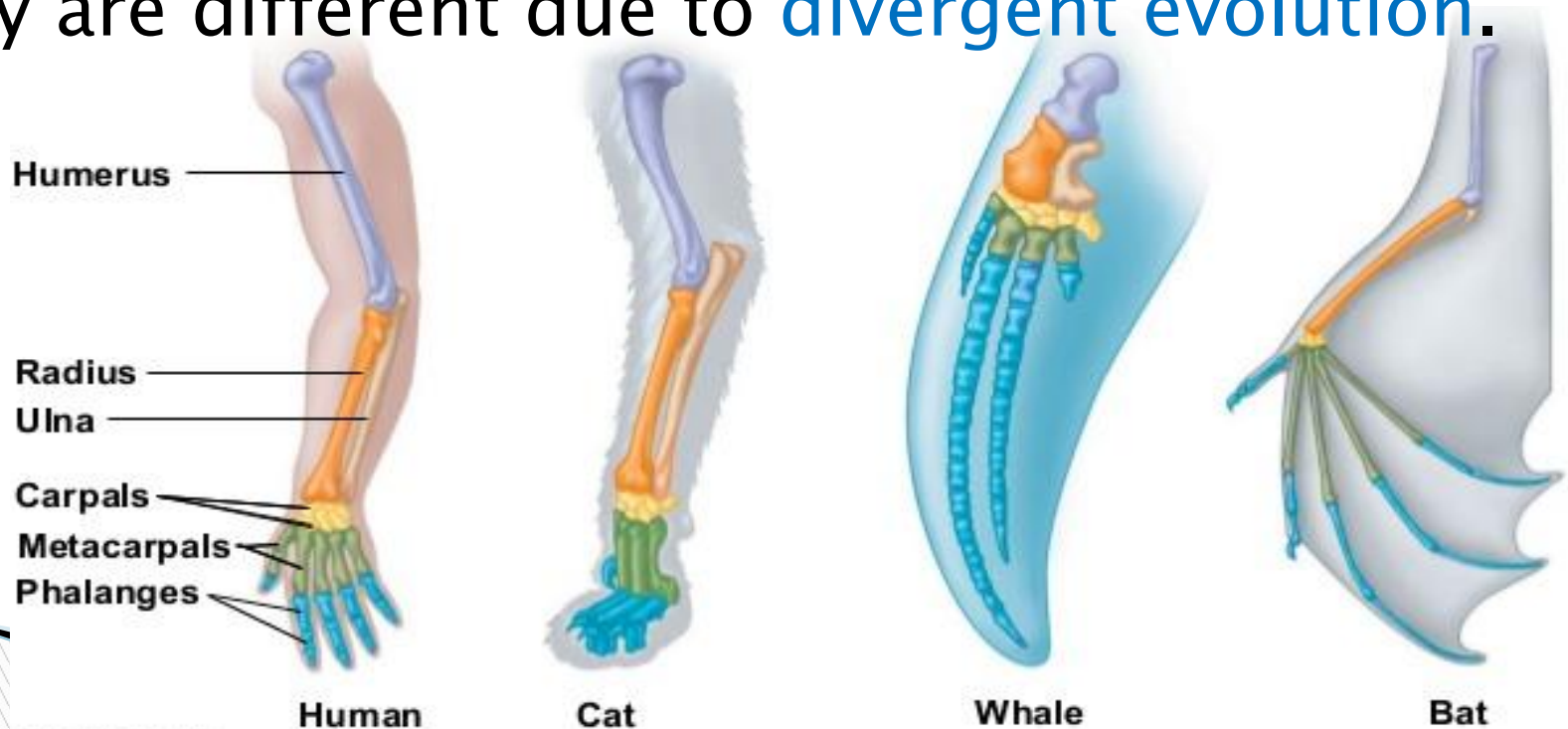


The diagram above shows the changes over time in the horse. Evidence for these changes most likely came from –

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3. Comparative anatomy (modification by descent)

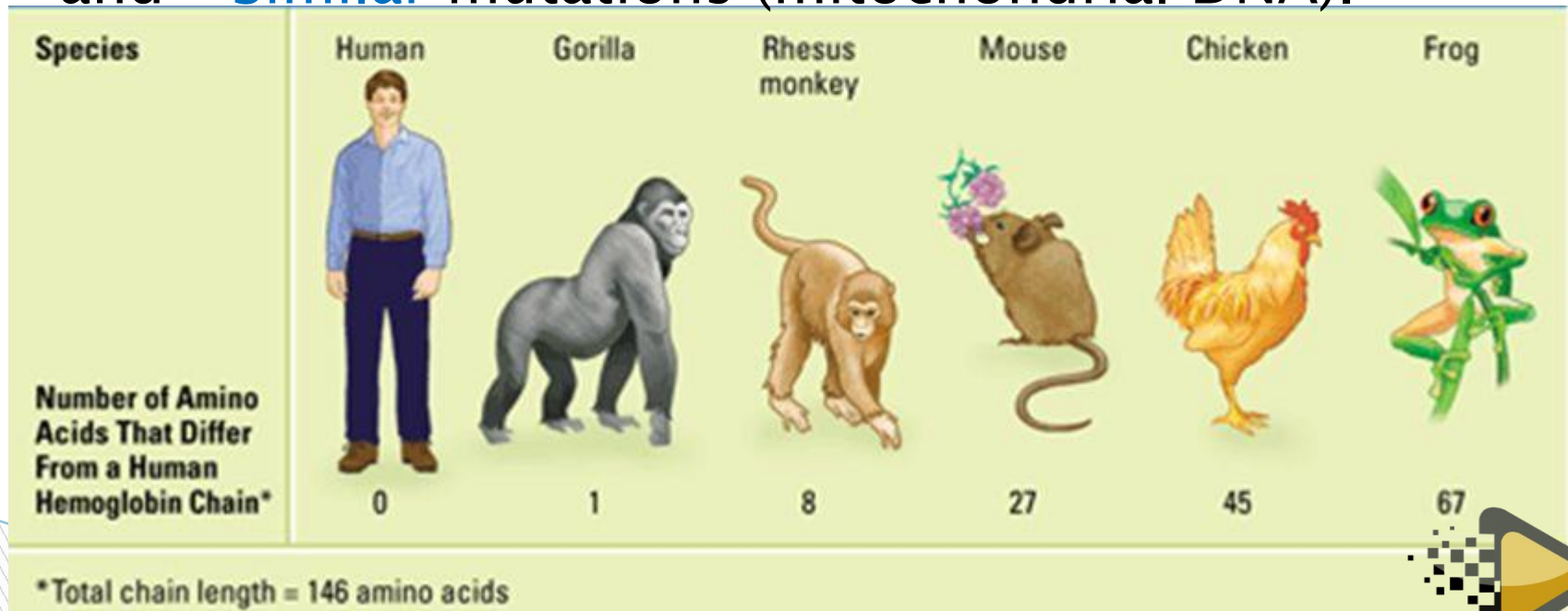
- Deals with similarities and differences in the anatomy of different species
- Organisms with the same ancestor have the same anatomical plan (pentadactyl limbs). But they are different due to divergent evolution.



Homologous

4. Genetic evidence

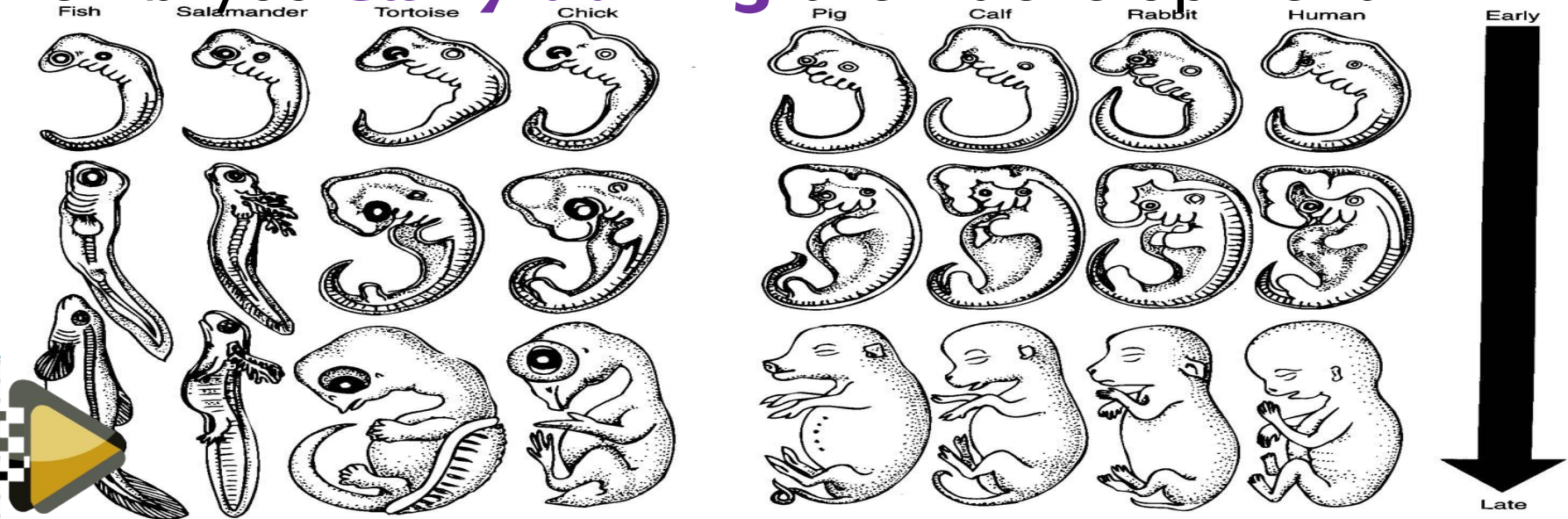
- One of the strongest evidences for common descent comes from gene sequences.
- Organism likely to have a **common ancestor** if they have:
 - – **Identical** DNA structure – **Similar** sequence of genes – Similar portions of DNA with no functions and – **Similar** mutations (mitochondrial DNA).



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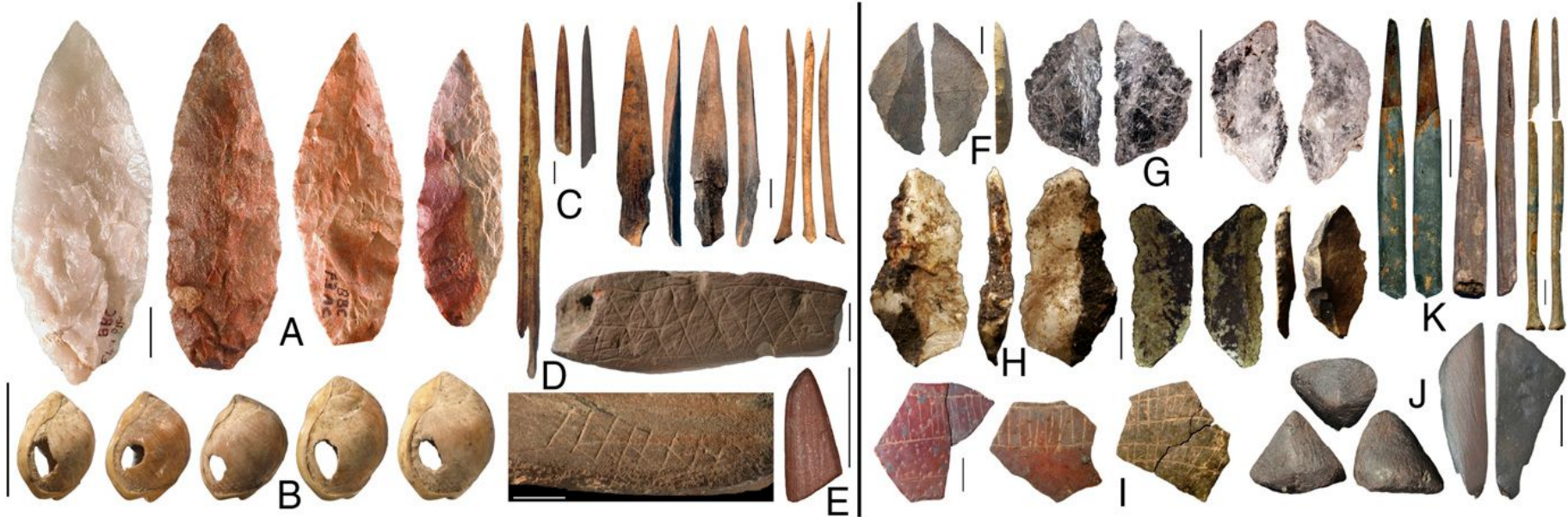
5.COMPARATIVE EMBRYOLOGY

- the study of the development of the **anatomy** of an organism to **its adult** form, provides evidence for **evolution** as embryo formation in **widely-divergent** groups of organisms tends to be conserved
- For **example**, vestigial structures such as **tails** or **gills** in humans can be found in embryos **early during** their development



6.Cultural evidence:

- Cultural evidence from studies of **tools** and **weapons**, as well as language is also used to show **similarities** and **differences** between humans and African apes. This is linked to human



VARIATION

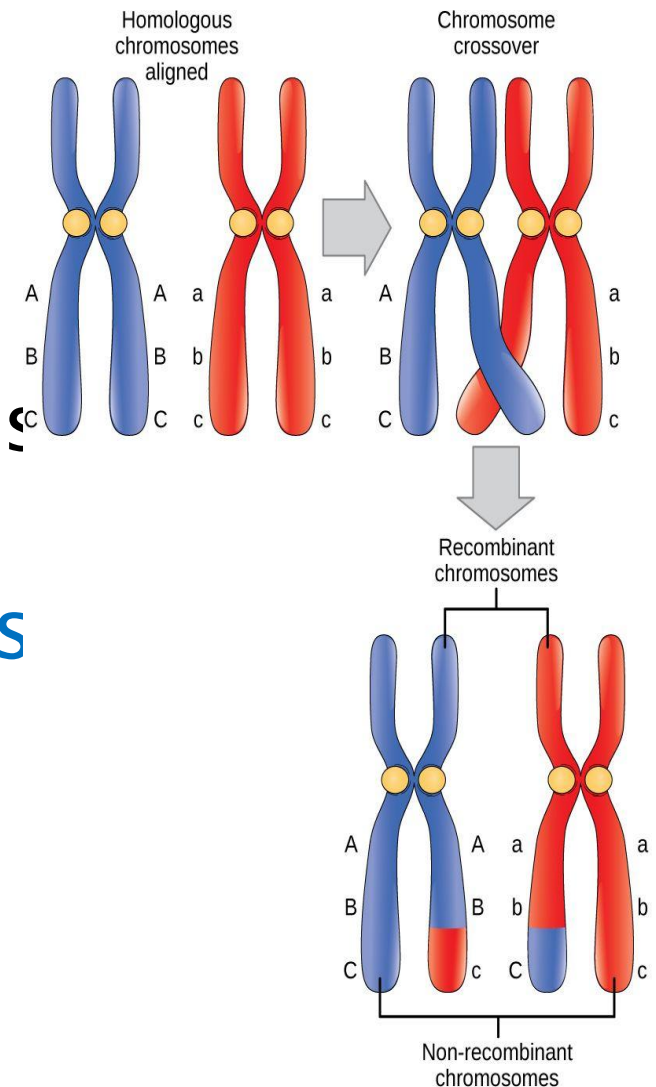
- Is the **differences** between organisms of **the same species**. It may be due to genetic factors or environmental factors.
- **A species** : is a group of **living organisms** consisting of similar individuals capable of **interbreeding** to produce a **fertile/ viable offspring**.
- **A population**: organisms of the **same species** living in a **particular geographical area** and are capable of interbreeding.



CAUSES OF VARIATION

1. CROSSING-OVER

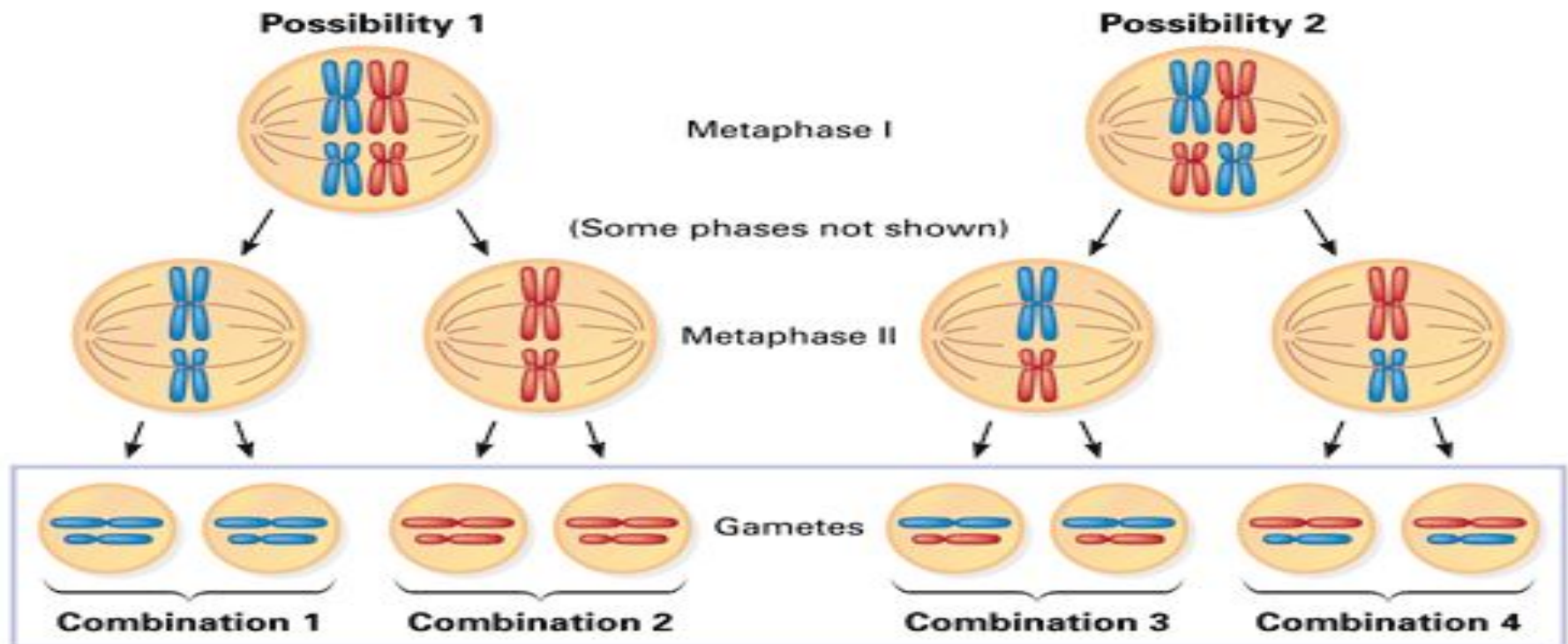
- When homologous chromosomes form pairs during **prophase I** of meiosis I, **crossing-over** can occur.
- leads to **new combinations** of maternal and paternal **genetic material** in each new cell



2. Random arrangement of chromosomes

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- The random arrangement of **chromosomes** during **metaphase** results in **gametes** with a **unique** combinations of **alleles**.
- at the **equator** during metaphase allows different combinations of **chromosomes/chromatids** to go into each new cell resulting from meiosis, making them different.



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3. Random fertilization



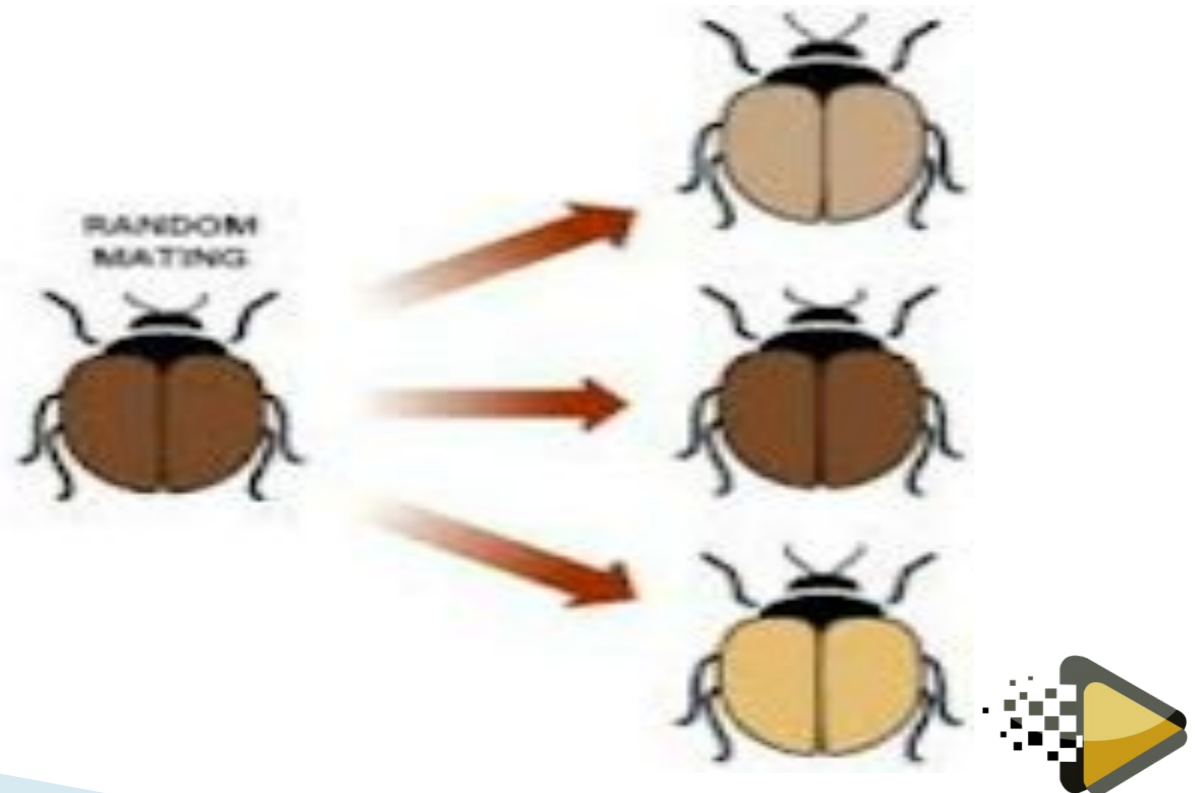
Any sperm cell stand a chance of fertilising any **egg cell/ovum**. between different **ovum** and different **sperm** cells formed by meiosis result in **offspring** that are **different** from each other.

Note: each individual is capable of producing over **8million** potential gametes, the **random** chance of any one sperm and egg coming together is a product of these two probabilities - some 70 **trillion different combinations** of chromosomes in a potential offspring.



4. Random mating

- Mating takes place within species randomly
- between organisms within a species leads to a different set of offspring from each mating pair.



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5. Mutation



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- **changes** the **structure** of a **gene** or chromosome and therefore the organism's genotype changes too.
- Since the genotype influences the phenotype, it creates organisms with **new, different characteristics** from one generation to the next.
- **Mutations could be**
 - Harmless mutation
 - Harmful mutation
 - Beneficial mutation



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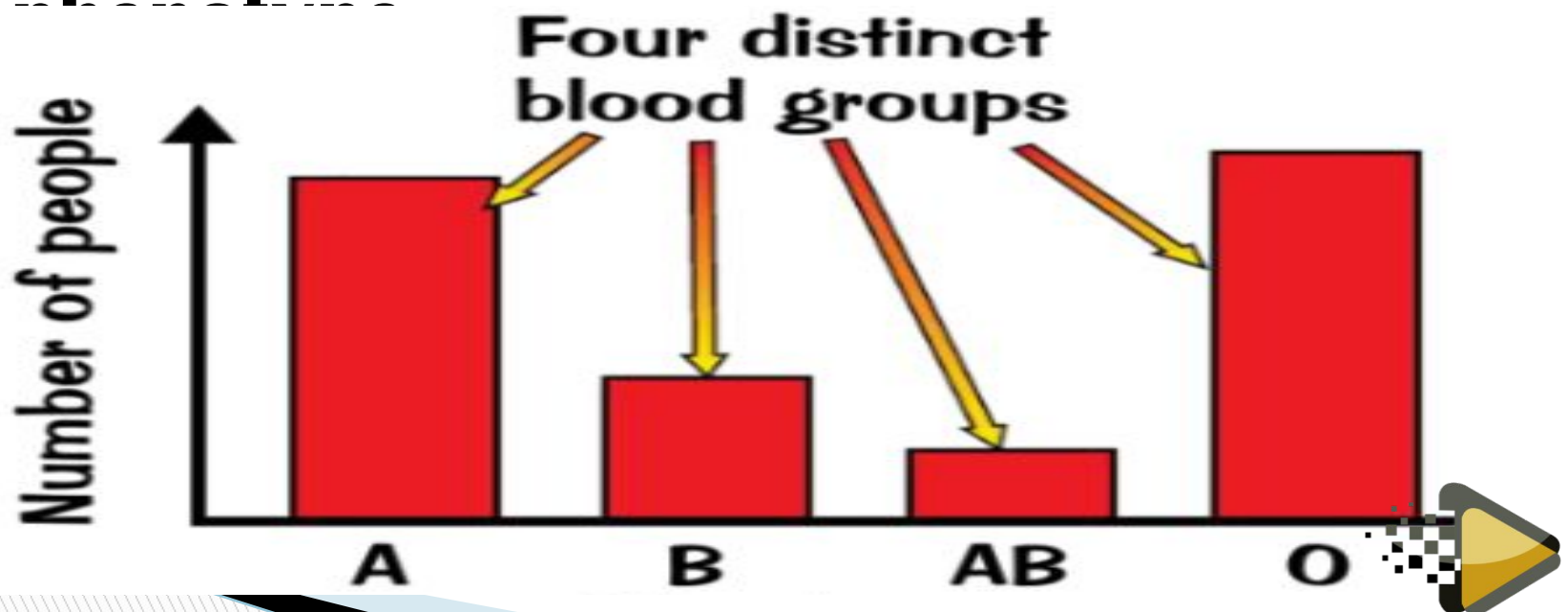
Continuous and discontinuous variation

- ▣ **CONTINUOUS VARIATION** this is the type of variation where there is arrange of characteristic.ie there is **intermediate values**.
 - Phenotype could be affected by **environment**.
- ▣ e.g. **height** and **weight**



❑ DISCONTINUOUS VARIATION

- ❑ Clearly **defined** differences in a characteristic that can be observed in a population. There is no **intermediate values**
- ❑ Eg. In the ABO **blood group** system, only four blood groups are possible (A, B, AB or O).
- ❑ Environment has **no effect on the**



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THEORIES OF EVOLUTION

- Lamarckism

(Jean Baptiste de Lamarck – 1744 – 1829)

- Darwinism

(Charles Darwin – 1809 – 1882)



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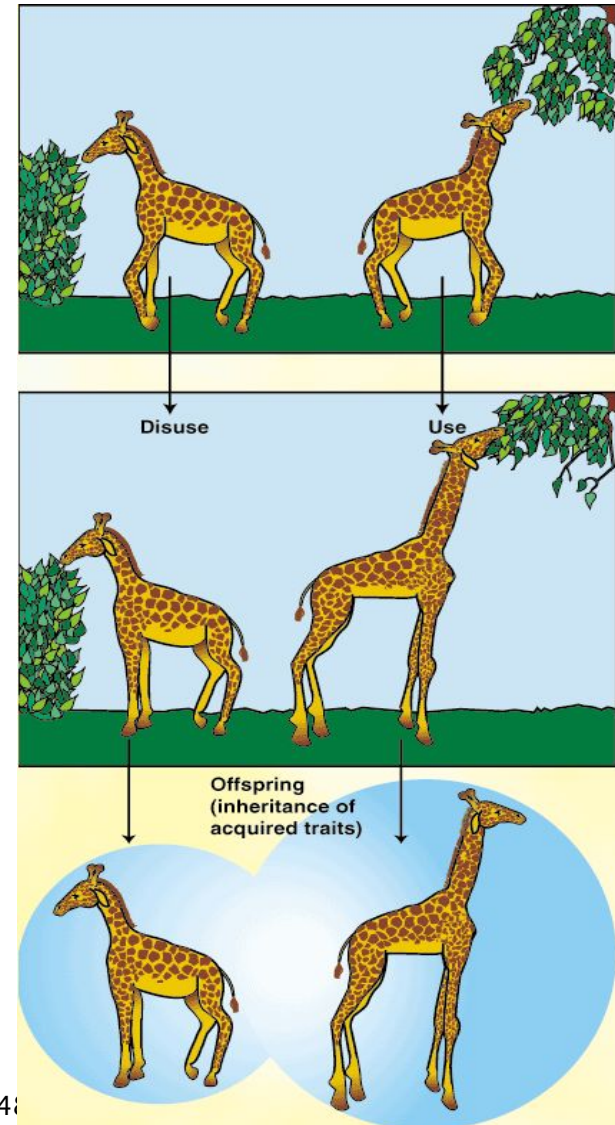


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Lamarckism

(Jean Baptiste de Lamarck – 1744 – 1829)

- Lamarck used two 'laws' to explain evolution:
- **1. The law of use and disuse:**
 - As an organism **uses** a structure or organ more **frequently**, it becomes better developed or enlarged.
 - If an organism **does not use** a structure or organ frequently, it becomes less developed or reduced in size and **may disappear** altogether.

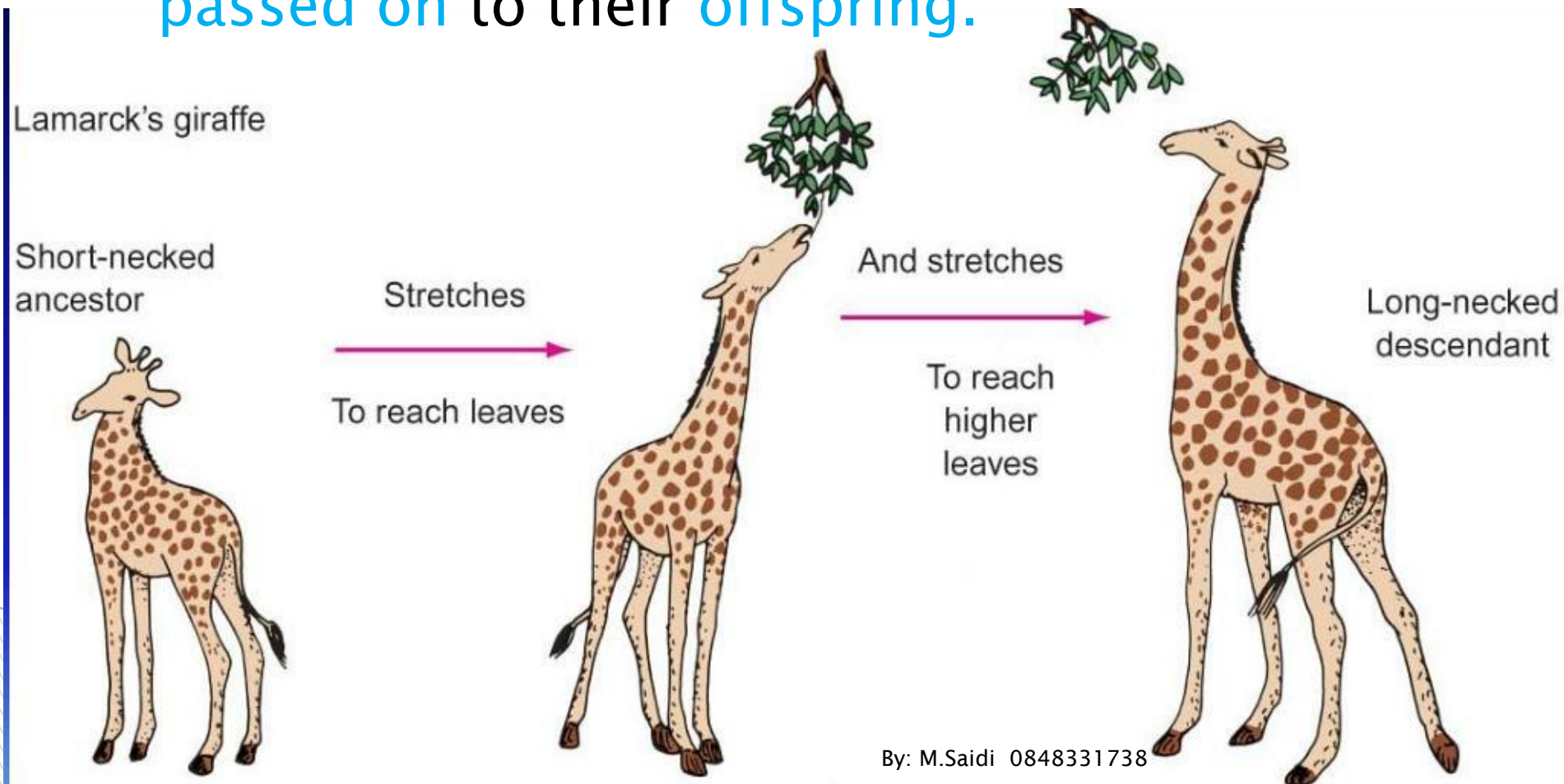


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❑ 2.The inheritance of acquired characteristics

- ❑ Characteristics developed during the **life** of an individual (acquired characteristics) can be **passed on** to their **offspring**.



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QUESTIONS

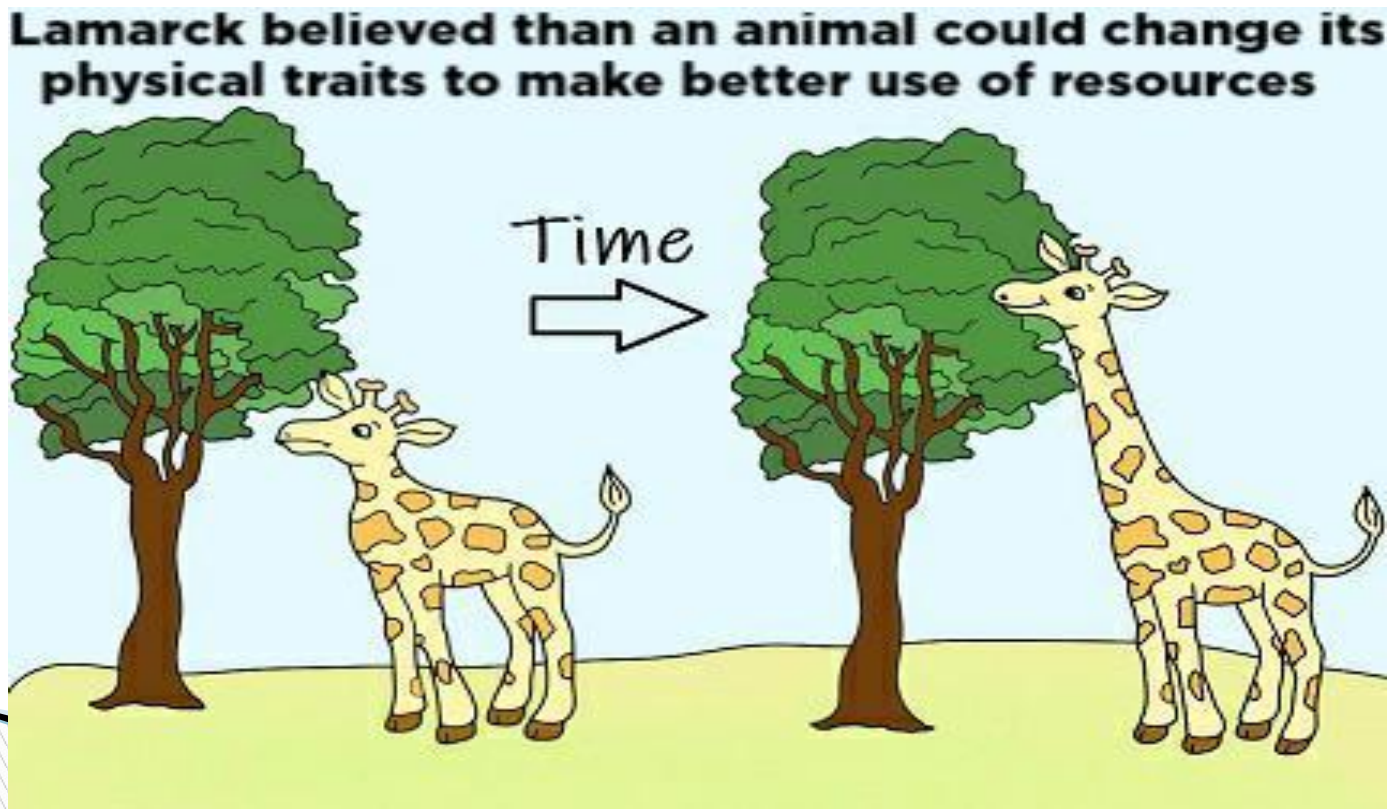
- 1. Write an account showing how **Lamarck** would have **explained** the development of **longer necks** in modern giraffes. (5)

MEMO

- All giraffes had **short necks** originally.
- These giraffes **frequently stretched** their necks
- They did this to **reach the leaves** that were **available only higher up** on the trees.
- As a result, their **necks became longer**
- The characteristic of **long necks** acquired in this way was then **passed on** to the **next generation**.
- Eventually all the giraffes had **longer necks**

❑ 2. Explain why Lamarck's theory was rejected.

- ❑ There is **no enough evidence** to show that **acquired characteristics are inherited**
- ❑ Organisms did **not evolve** because they **want to evolve**



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DIFFERENCES BETWEEN LAMARCKISM AND DARWINISM

LAMARCKISM	DARWINISM
Variation of the offspring occurs when individuals in the population change	Variation in the offspring is inherited
Change occurs because of adaptation to the environment □ / Law of use and disuse/ deterministic theory	Natural selection – individuals best suited to the environment survive
Individuals in the population change	The population as a whole change
Acquired characteristics are inherited by offspring	Characteristic are passed on from generation to generation to enable individuals to survive in the environment



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Darwinism

(Charles Darwin – 1809 – 1882)



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- Its by **natural selection**:
- Organisms produce a **large number** of offspring.
- There is a great deal of **variation** amongst the offspring.
- Some have **favourable characteristics** and some **do not**.
- When there is a **change in the environmental** conditions or if there is competition
- Then organisms with favourable characteristics, **survive** while organisms with unfavourable characteristics, **die**.
- The organisms that survive, **reproduce** and thus **pass on** the **allele** for the favourable characteristic to **their offspring**.



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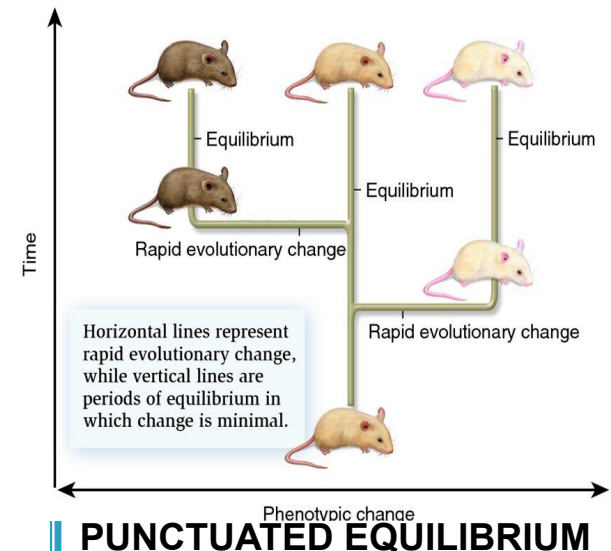
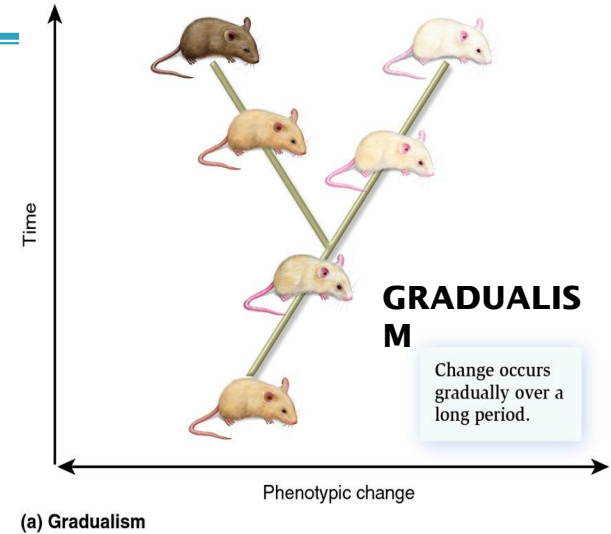
Qn 3. Write an account showing how Darwin would have explained the development of longer necks in modern giraffes.

- As a result of **genetic variation** in the giraffe population some giraffe **had longer necks** than others.
- As a result of **leaves** being **available** only **higher up on trees**,
- giraffes **competed** for these leaves.
- • Giraffes with **shorter necks** died.
- • Giraffes with **longer necks** survived.
- • This is **natural selection**.
- • **The allele** for longer necks was **passed on** to subsequent generations.
- • Eventually all the giraffes **had longer necks**.

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Punctuated Equilibrium (Eldredge and Gould – 1972)

- It explains the **speed at which evolution takes place**:
- Evolution involves **long periods of time** where species do **not change** or change gradually through natural selection (known as **equilibrium**)
- This alternates with (is **punctuated** by) **short periods of time where rapid changes occur** through natural selection during which new species may form in a short period of time.



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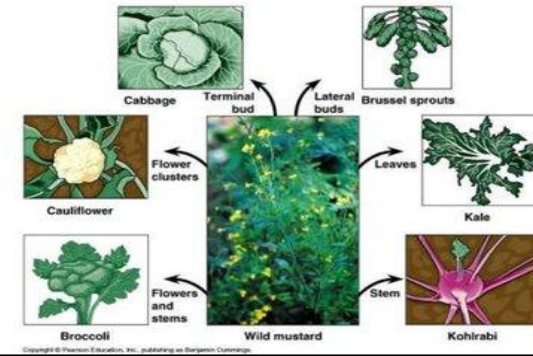
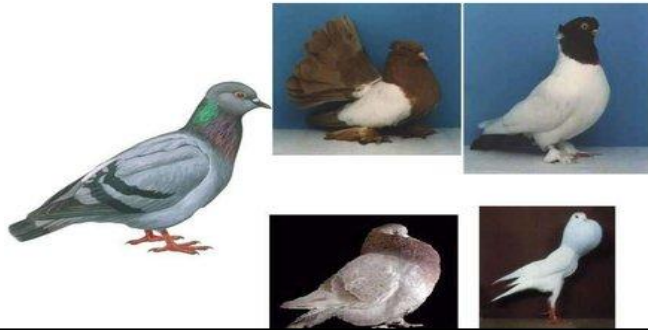
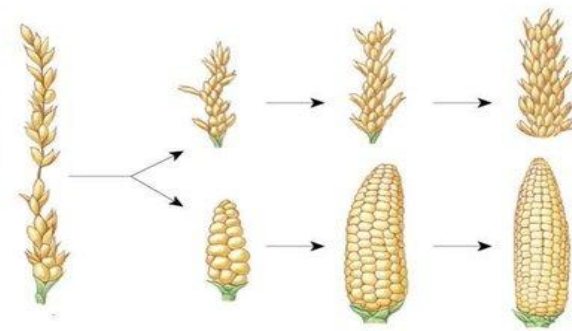
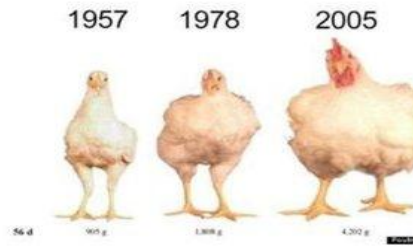
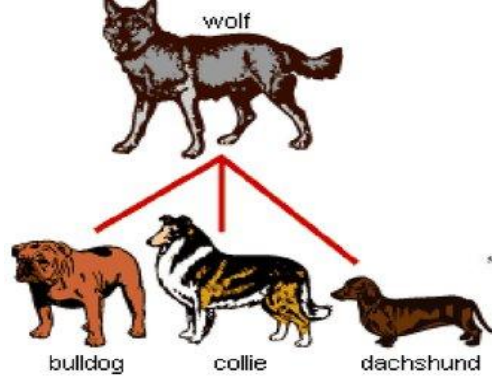
ARTIFICIAL SELECTION

- is where **humans select** for **desirable traits** in agricultural products or animals, **rather than leaving** the species to evolve and change gradually without human interference.
- For a long time, humans have been doing breeding experiments to develop organisms with a **selected set of desirable** characteristics,
- FOR EXAMPLE
- increased quality and quantity of **milk produced** by COWS
- **Drought resistance** organisms
- **Disease resistant** organism
- **increased sugar** content in sugar cane.



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Selective breeding of cows

- **Suppose you wanted a variety of cow that produced a lot of milk.**
- choose or select the cows in your herd that produce the most milk
- let only these cows reproduce
- select the offspring that produce the most milk
- let only these offspring reproduce
- keep repeating the process of selection and breeding until you achieve your goal.

Differences between natural selection and artificial selection

Natural selection	Artificial selection
The environment or nature is the selective force.	Humans represent the selective force.
Selection is in response to suitability to the environment.	Selection is in response to satisfying human needs.
Occurs within a species.	May involve one or more species (as in cross breeding).



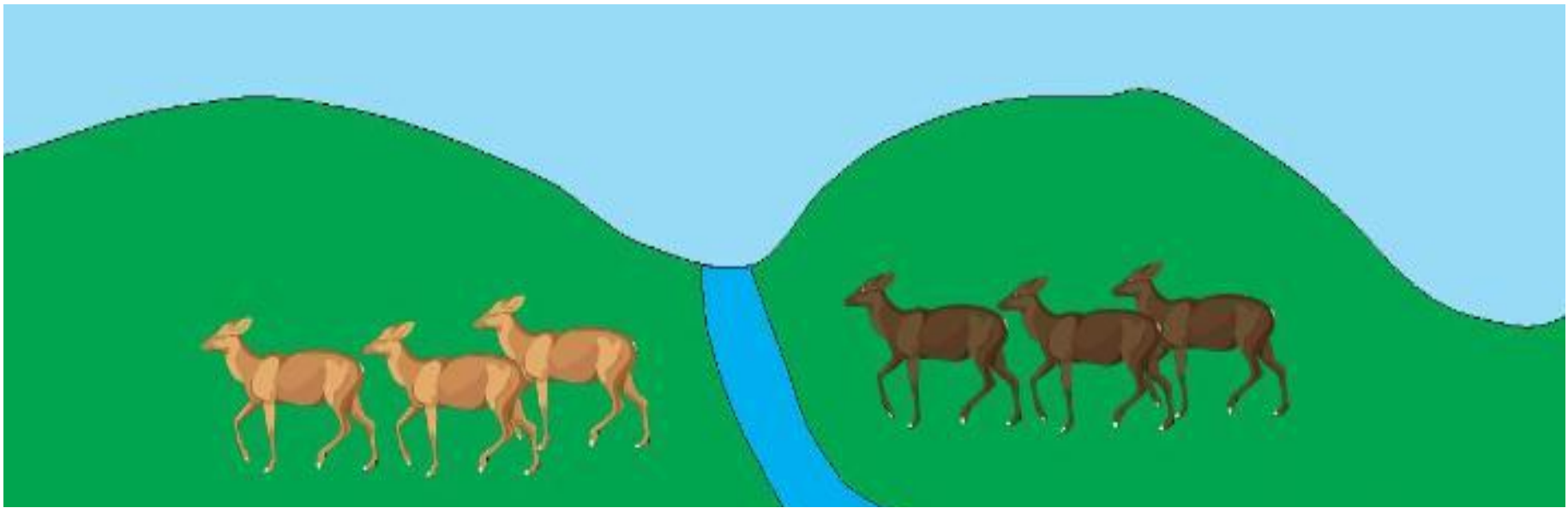
SPECIATION

This is the **formation of new species**
process of speciation

- A population of a particular species may become **split** into **two** by a **geographical barrier**, e.g. a river, mountain.
- As a result, the **two parts** of the population **cannot interbreed**.
- There is **no gene flow** between the two populations.
- **Natural selection** occurs **independently** in each population.
- This is due to **different environmental conditions**.
- As a result, the two populations become **genotypically** and **phenotypically different** over a period of time.
- Even if the **two populations mixed** at a later time,
- they will **not be able to interbreed** again to produce **fertile offspring**.
- **one or both populations** have become a **new species**.

- Some finches have large, blunt beaks that can crack the hard shells of nuts and seeds.
- Other finches have long, thin beaks that can probe into cactus flowers without the bird being poked by the cactus spines.
- Still other finches have medium-size beaks that can catch and grasp insects.
- Because they are **isolated**, the birds **don't breed with** one another and have therefore developed into unique species with **unique characteristics**.
- This is called **allopatric speciation**.

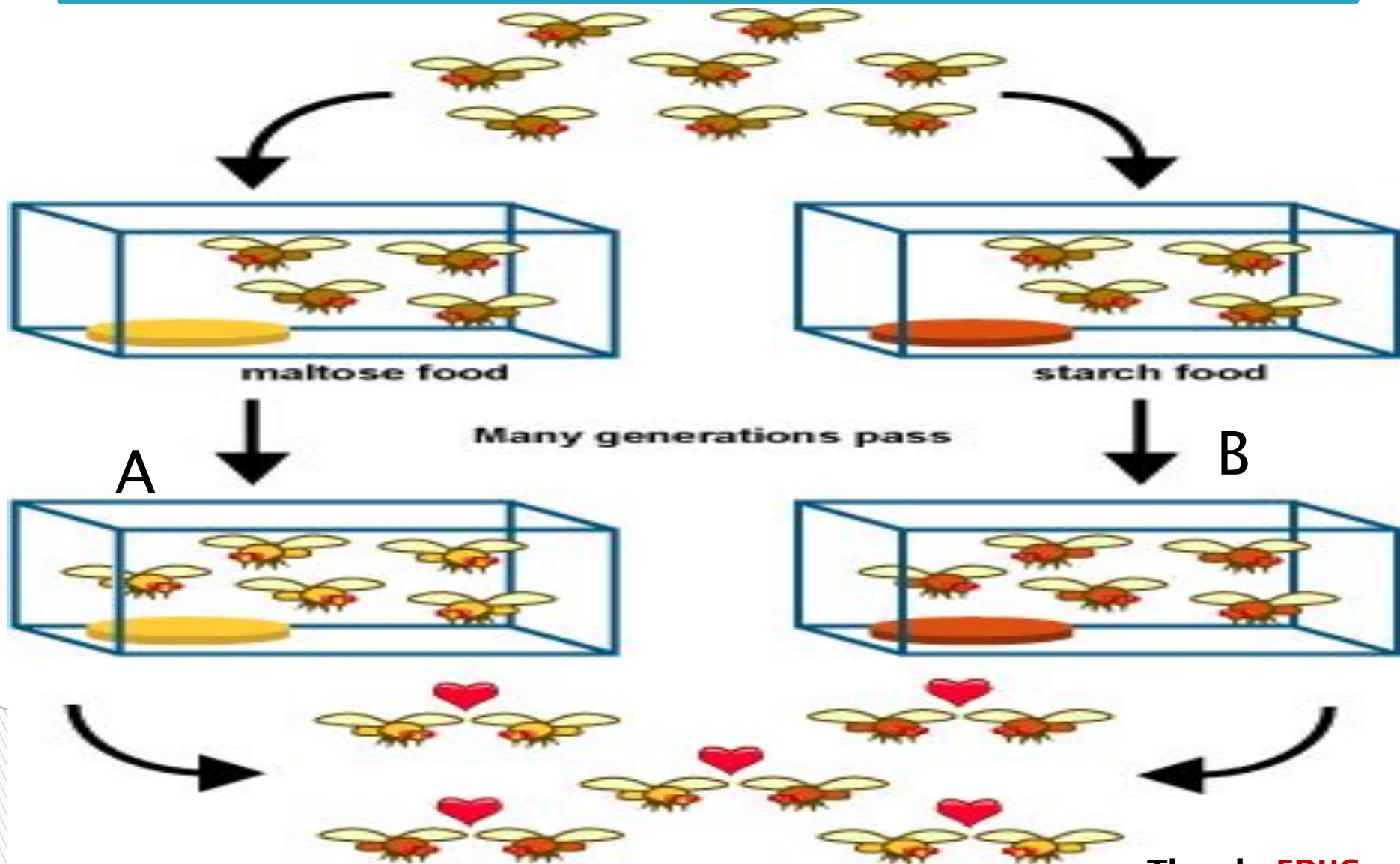




Other examples

- Galapagos tortoises
- Plants on different land masses (linked to continental drift)
 - Baobabs in Africa and Madagascar
 - Proteas in South Africa and Australia

Qn: Describe how these two species of flies formed. (6)



- There was one population of flies
- A population of a **fly species** becomes **separated** P by **walls of the boxes** P into two populations A and B
- There is **no gene flow** between the separated population. P
- **Natural selection occurs independently** in each population A and B P due to exposure to **different environmental** conditions P/food source.
- Populations **become very different** P from each other **genotypically and phenotypically** P
- When populations were allowed to **meet again**, P they were **not be able to interbreed**. P to produce a fertile offspring
- The populations A and B are **now new species**.

P=point / mark

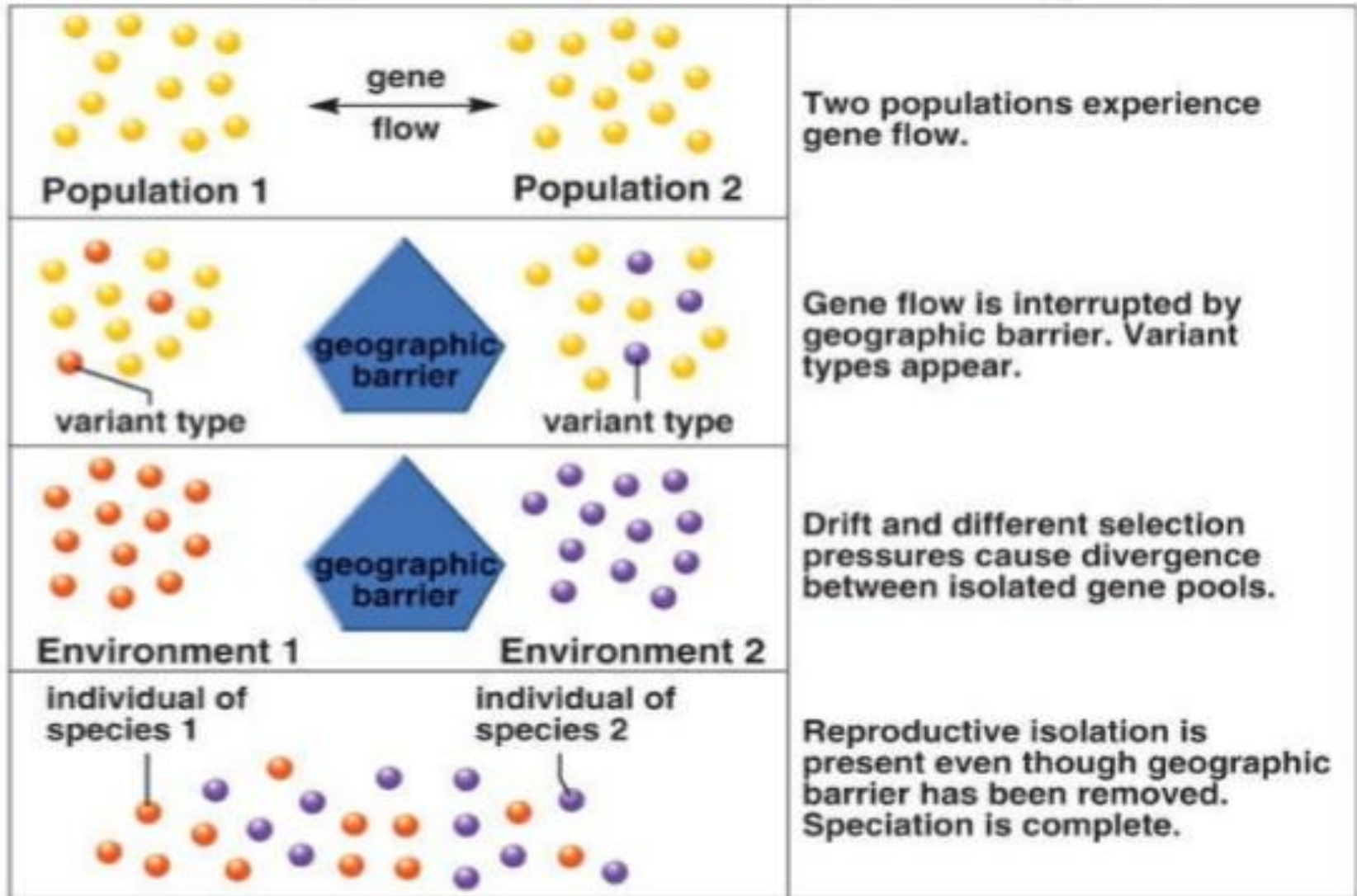
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Qn: Describe how these two species formed. (6) **try it**



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Mechanisms of reproductive isolation

□ (Keeping species separate)

□ Breeding at different times of the year



The western and eastern spotted skunks breed at different times of the year (fall and late winter).

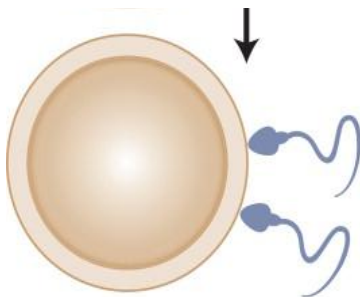
□ Species-specific courtship behaviour



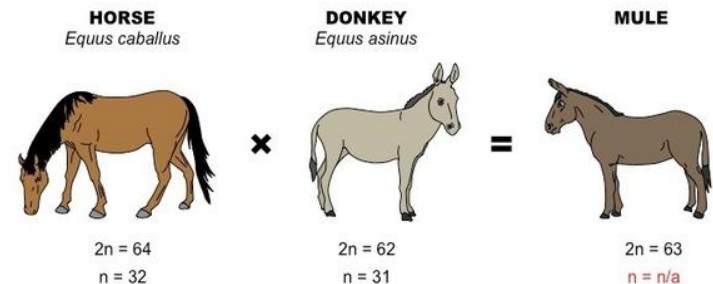
□ Adaptation to different pollinators



□ Prevention of fertilisation



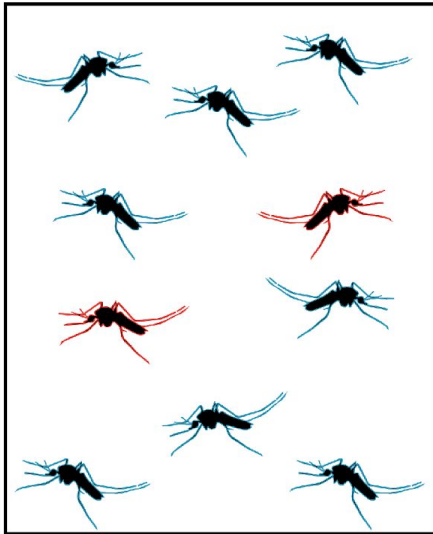
□ Infertile offspring



EVOLUTION IN PRESENT TIMES

Describe how **mosquitoes** developed resistant to **DDT**

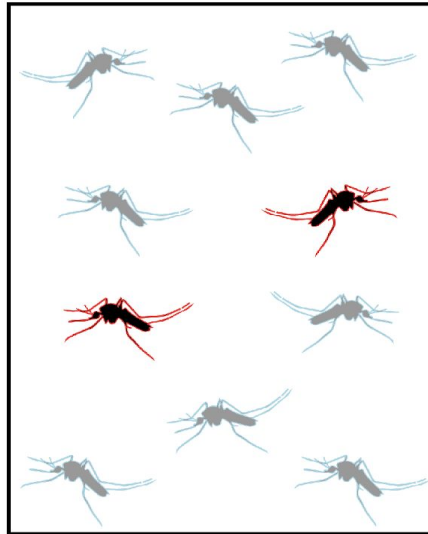
1.



A few mosquitos have **DDT resistant alleles**
Most mosquitos have **non-resistant alleles**

DDT is sprayed

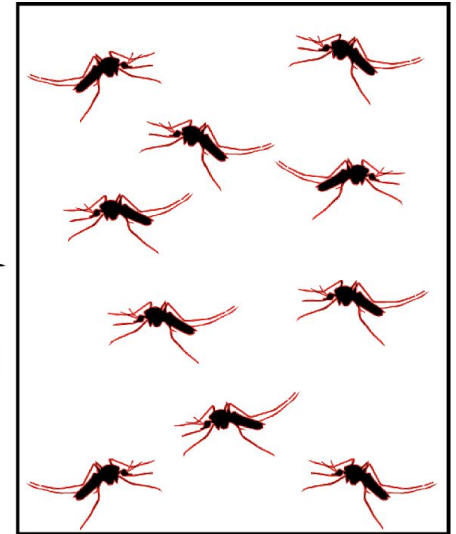
2.



Mosquitos with **resistant alleles** survive
Mosquitos with **non-resistant alleles** die

Survivors
reproduce
over several
generations

3.



Population now consists entirely of
mosquitos with **resistant alleles**

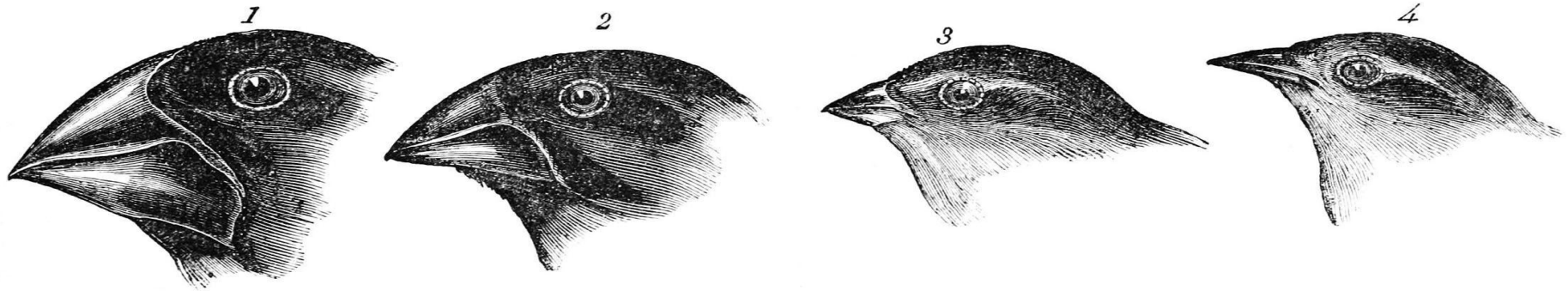


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- There is a large degree of **variation** in the mosquito population
- When the DDT was first used, **it killed off a large number** of mosquitoes
- But some mosquitoes were **resistant** to the DDT and **survived**
- Those that survived were able to **reproduce**
- Increasing the population of resistant mosquitoes
- **Continued use** of the DDT had **little effect** on the resistant mosquitoes
- Hence the **resistant** mosquitoes **increased**
- And **non-resistant** mosquitoes **decreased**



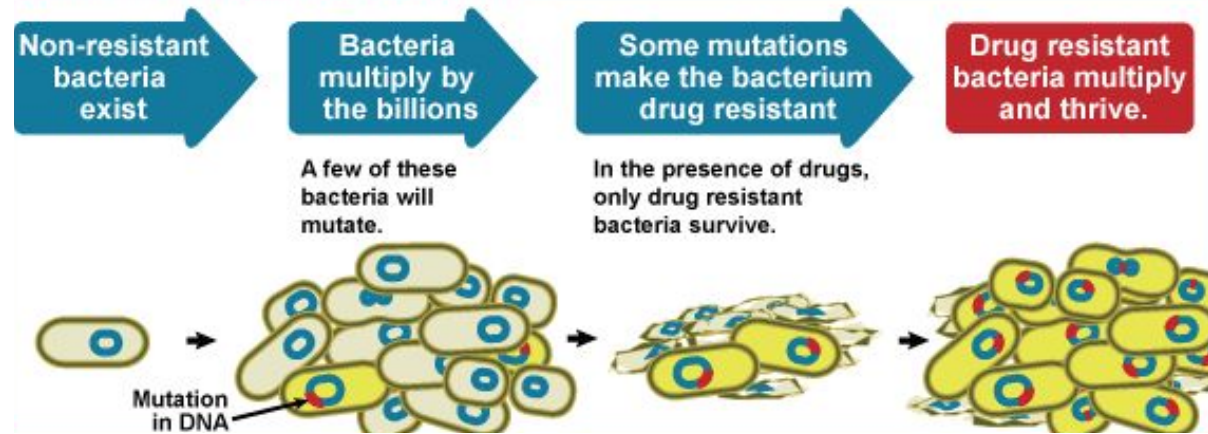
Describe how Bill (beak) and body size of Galapagos finches developed



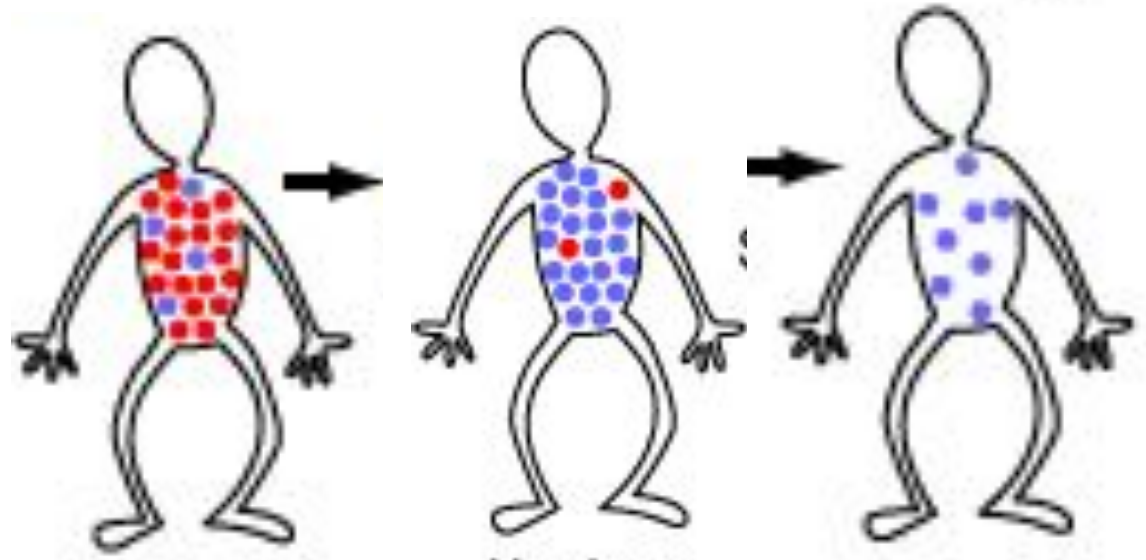
- ❑ The ancestral finch was a **ground-dwelling, seed-eating** finch.
- ❑ The ecological niches exert the **selection pressures** that push the populations in various directions.
- ❑ A drought on the **Galápagos** island reduced the **number of small seeds** available to **finches**, causing many of the small-beaked **finches** to die.
- ❑ This caused an increase in the **finches'** average **beak size**.

Other examples explain with help of the teacher

□ Development of resistant strains of tuberculosis-causing bacteria (MDR and XDR) to antibiotics, due to mutations (variations) in bacteria and failure to complete antibiotic courses



□ HIV resistance to antiretroviral medication



PART 2

human evolution

By: M.Saidi



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