

# Variation and Evolution

## LEARNING OUTCOMES

- ▣ Define the term variation.
- ▣ Discuss the fact that variation occurs within, as well as between, species.
- ▣ Describe the differences between continuous and discontinuous variation, using examples of a range of characteristics found in plants, animals and other organisms.
- ▣ Explain both the genetic and the environmental causes of variation.

# Are individuals in a population of a species the same?

- No – all members of a species share the common characteristics of that species, but there are still differences

- **Variation** – differences between individuals of the same species

- EX. All dogs have hair, but not all dogs have the same color hair



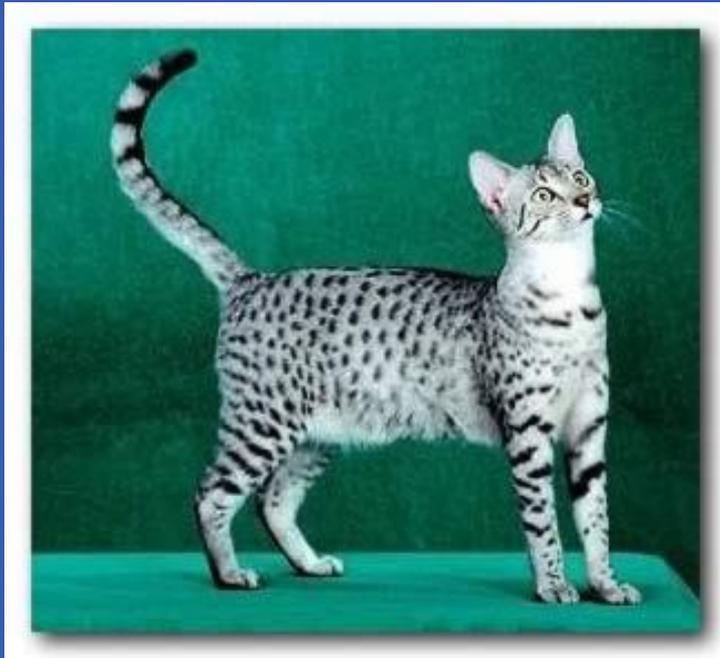
# Dog Variation



# Variation and Evolution

- ▣ Give a **definition** of Variation

Variation is the range of differences that there are between individual organisms.



# Variation and Evolution

Variation can be *within* species

(Think of all the differences between individual humans)

These are different varieties of the same species



# Variation and Evolution

Or *between* species:

Gorilla



Proboscis monkey



# Variation and Evolution

Variation can be  
**CONTINUOUS,**

ie have any value between  
two extremes.

Eg:

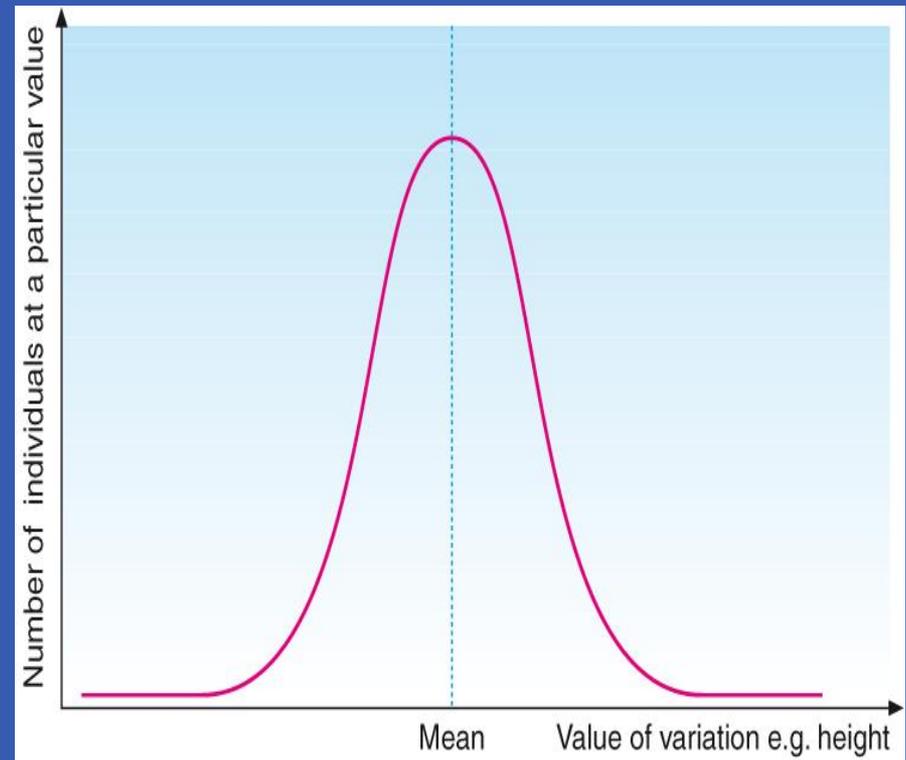
Height of human

Body mass of cats

Trumpet length of daffodils

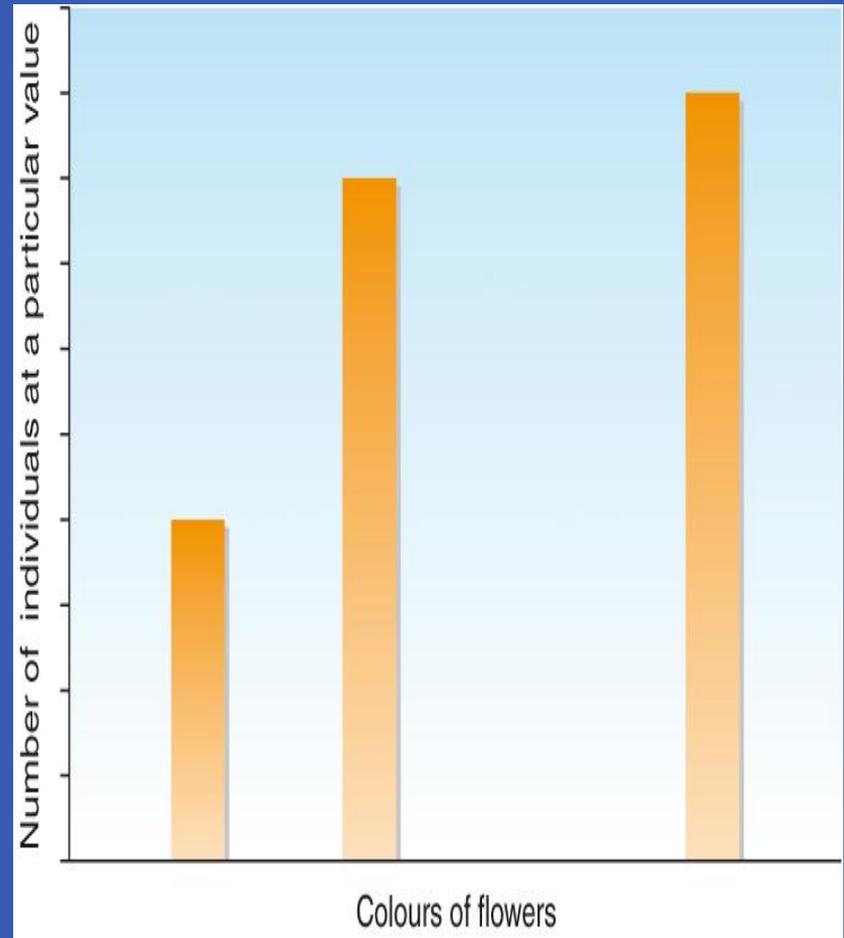
Leaf width of shrub

Length of bacteria



# Variation and Evolution

- Variation can be **DISCONTINUOUS** , in this case there only a few possible categories that the characteristic can fall into.
- EG:
  - Flower colour in a single species
  - Human blood group or ear lobe type
  - Bacteria that are or are not resistant to an antibiotic



# Variation and Evolution

## Genetic variation

Each tomato is different because it comes from a plant with different *alleles*, that code for different characteristics



## Environmental variation

These plants are genetically identical, the flower colour difference is due to the effects of soil pH.



# Variation and Evolution

## GENETIC

Differences that are due to the DNA *inside* the cells of the organism rather than the effect that its surroundings have on it.



## ENVIRONMENTAL

Differences that are due to the *external* environment. For example availability of water, nutrients, light, prevailing winds.



# What causes variation?

There are 2 main causes of variations in a population:

- 1. Mutation** – A change in the DNA of an organism that leads to a change in a protein being made by the organism
  - Sometimes the new protein can lead to a new trait
  - Mutations can be caused by DNA being copied incorrectly during replication, by mistakes during meiosis, or by radiation or chemicals in the environment

# What causes variation?

There are 2 main causes of variations in a population:

- **Recombination** – The creation of a new set of DNA in offspring during sexual reproduction
  - Since each parent passes down only  $\frac{1}{2}$  of their DNA, the DNA in the offspring is a unique combination of DNA from both parents

# Variation and Evolution

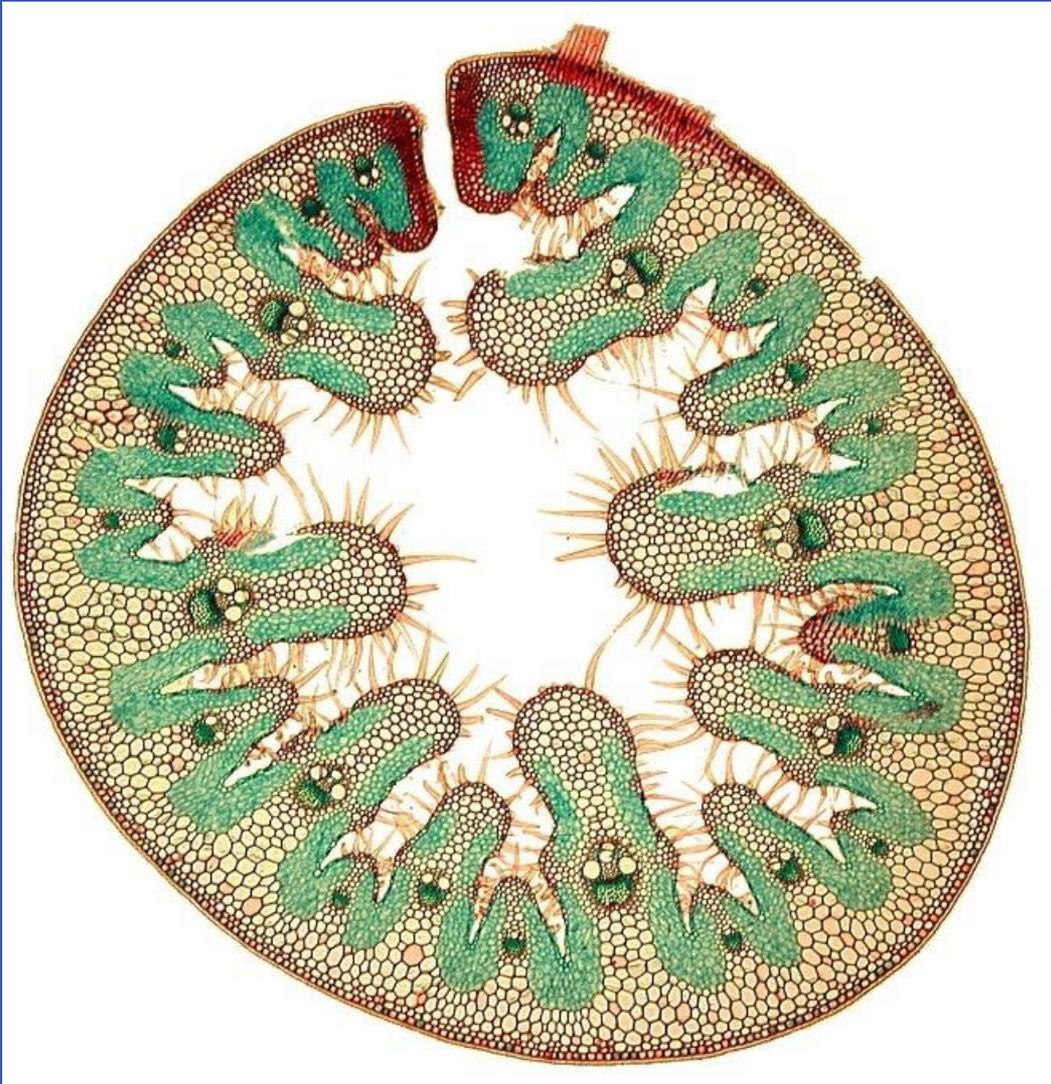
- ▣ Many of the differences between species are present because they help the individuals to survive.
- ▣ We call these differences **ADAPTATIONS**.  
You should understand that there are Adaptations to:  
**ANATOMY** or body FORM,  
**PHYSIOLOGY** or body FUNCTION  
**BEHAVIOUR**

# Variation and Evolution



- ▣ SAGUARO CACTUS
- ▣ Accordion folded stem is fleshy to store water
- ▣ Roots mostly less than 15cm deep but cover huge area
- ▣ 1 deep tap root
- ▣ Can absorb 750 litres water in a single storm
- ▣ Leaves reduced to spines to reduce transpiration rate
- ▣ Waxy cuticle reduces transpiration
- ▣ Stomata only open at night

# Variation and Evolution



- ▣ Adaptations of Marram Grass, a *xerophyte*
- ▣ Rolled leaf
- ▣ Thick cuticle
- ▣ Sunken stomata
- ▣ Epidermal hairs

What is the *purpose* of these adaptations?  
Explain how they work

# How does variation lead to evolution?

1. **Structural Adaptation** – a physical trait that helps an organism to survive (EX. the sharp teeth of a lion, the spines of a cactus)



# How does variation lead to evolution?

- 2. Behavioral Adaptation** – a behavioral trait that helps an organism to survive (EX. plover birds faking injury to lure predators away from nest)



# Variation and Evolution

- ▣ Outline the behavioural, physiological and anatomical (structural) adaptations of organisms to their environments
- ▣ You should be able to suggest several different types of adaptations of organisms that help them to survive.
- ▣ Make note of some examples from the "Journey of Life" DVD
- ▣ Choose one example from the DVD and research further

# Variation and Evolution

- ▣ Explain the consequences of the four observations made by Darwin in proposing his theory of natural selection.
- ▣ What are the 4 observations that Darwin made?
- ▣ 1. Offspring generally appear similar to parents.
- ▣ 2. No two individuals are identical. (Why not?)
- ▣ 3. organisms have the ability to produce large numbers of offspring
- ▣ 4. Populations in nature tend to remain fairly stable in size.
- ▣ *SO what are the consequences?*

# Variation and Evolution

- ▣ Because individuals over produce, yet populations remain stable COMPETITION must take place.
- ▣ In COMPETITION there are “winners” and “losers”. Winners are **better adapted** with more **useful characteristics**, they are more able to survive and breed, so **pass on their beneficial alleles**.
- ▣ Over time when this happens continually, accumulated changes can give rise to a new species.

# Variation and Evolution

Outline how variation, adaptation and selection are major components of evolution.

Differences in organisms

- ▣ How do they arise?
- ▣ Where do these changes happen?
- ▣ How can they be passed on?

# Natural Selection

- ▣ Variation in organisms characteristics are caused by the organisms having **different alleles of genes**.
- ▣ Some differences enable the organism to **survive better (compete more successfully)**
- ▣ The ones with beneficial alleles **survive, breed and pass on their alleles** to the next generation
- ▣ Those without beneficial alleles **die before they reproduce**, so their alleles are less likely to be passed on.
- ▣ The beneficial alleles **increase in frequency** in the population and may eventually produce a new species.

# Selection Pressures

- ▣ Competition for food, water, minerals
- ▣ Predation, grazing
- ▣ Disease
- ▣ Physical and chemical factors
- ▣ Competition for mates
- ▣ Competition for space, nesting sites, territory etc

An allele that helps an organism compete better is  
"selected for", increases in frequency

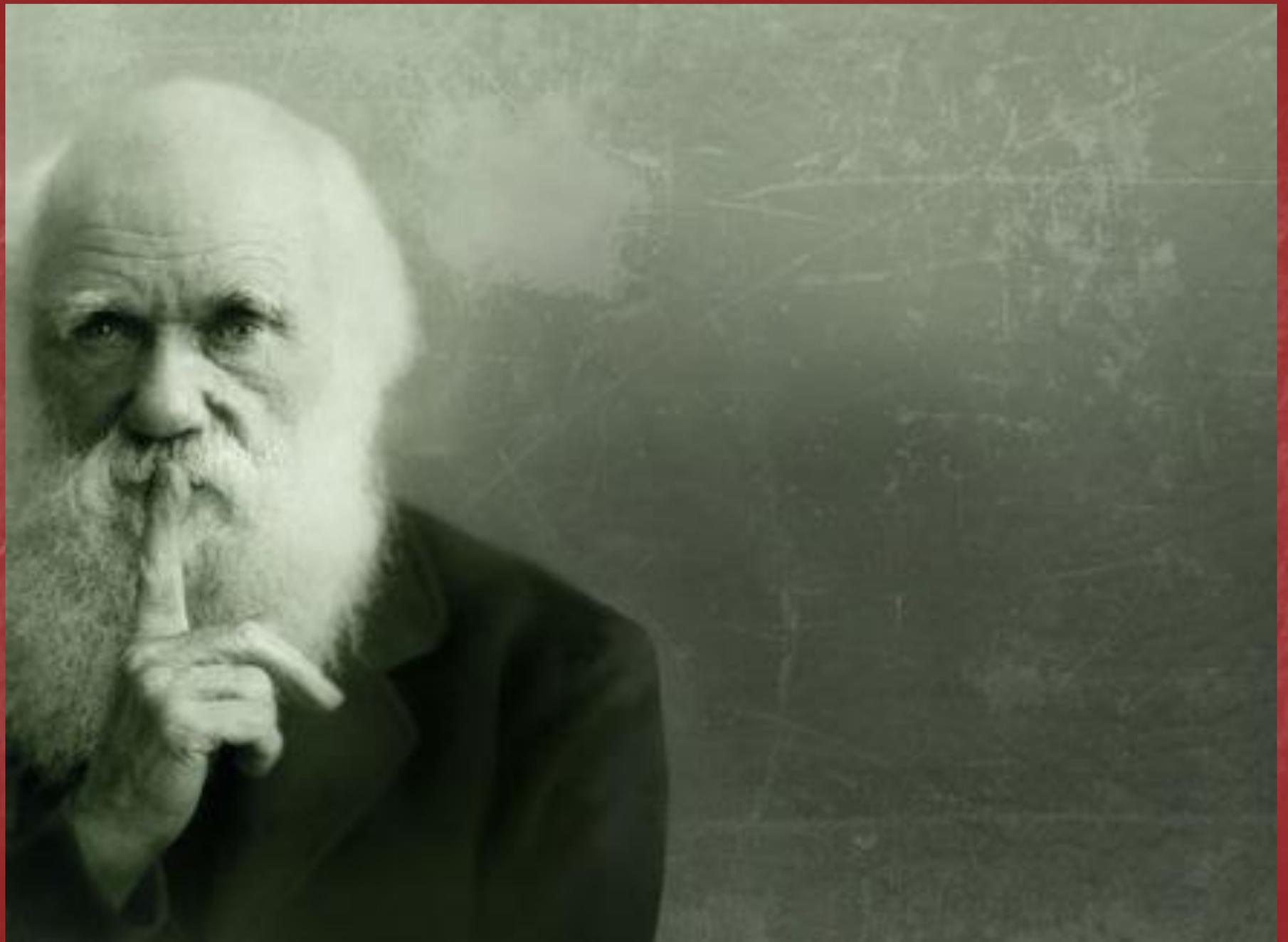
An allele that fails to help an organism survive is  
usually "selected against", decreases in  
frequency

# How does variation lead to evolution?

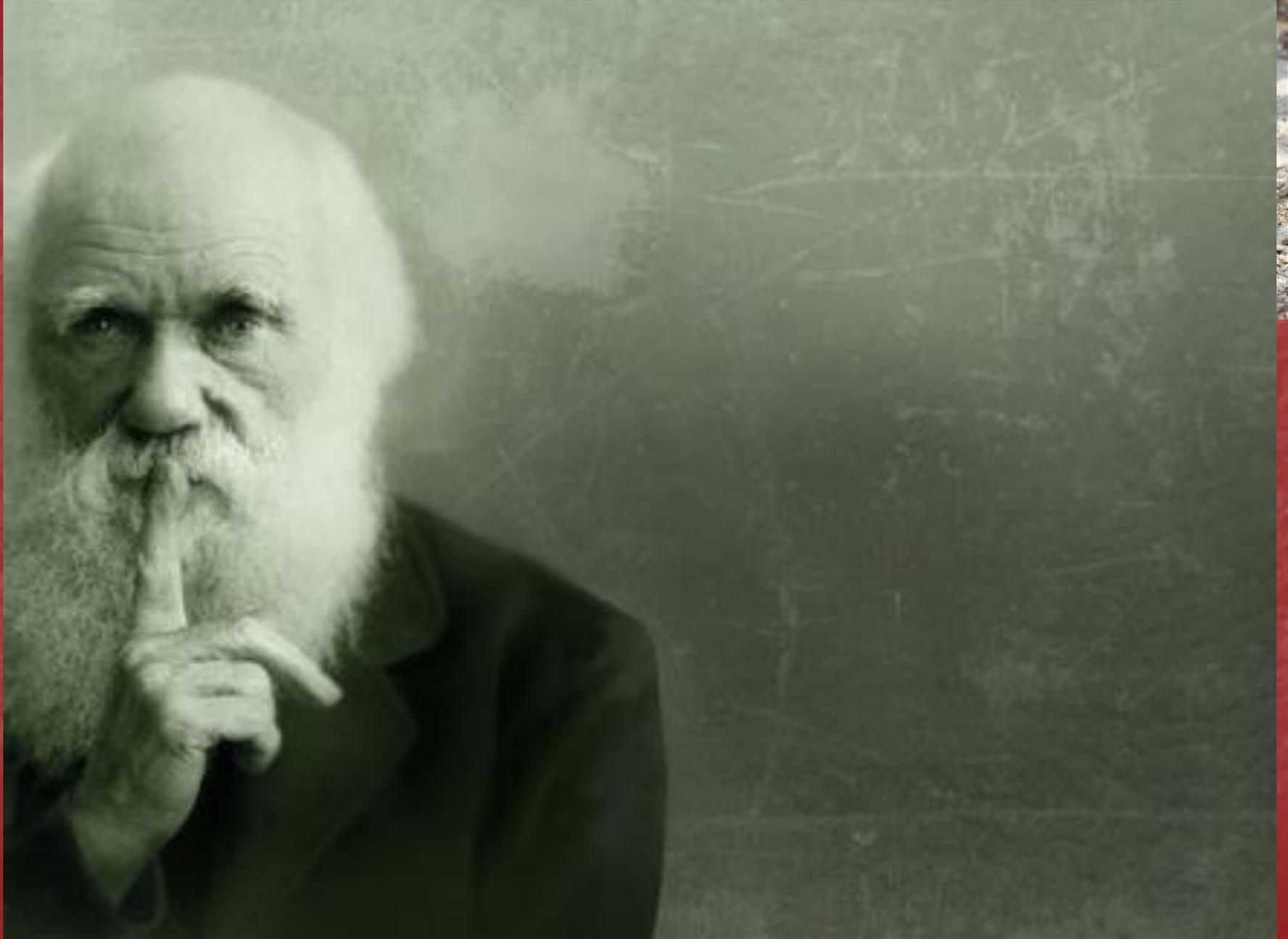
- Adaptations are traits which means they are caused by genes
- Organisms with the best adaptations have the “best” genes and highest fitness
- These organisms survive and reproduce more, passing on their genes, and changing the relative frequency of genes in the gene pool of the next generation (“good” genes appear more frequently)

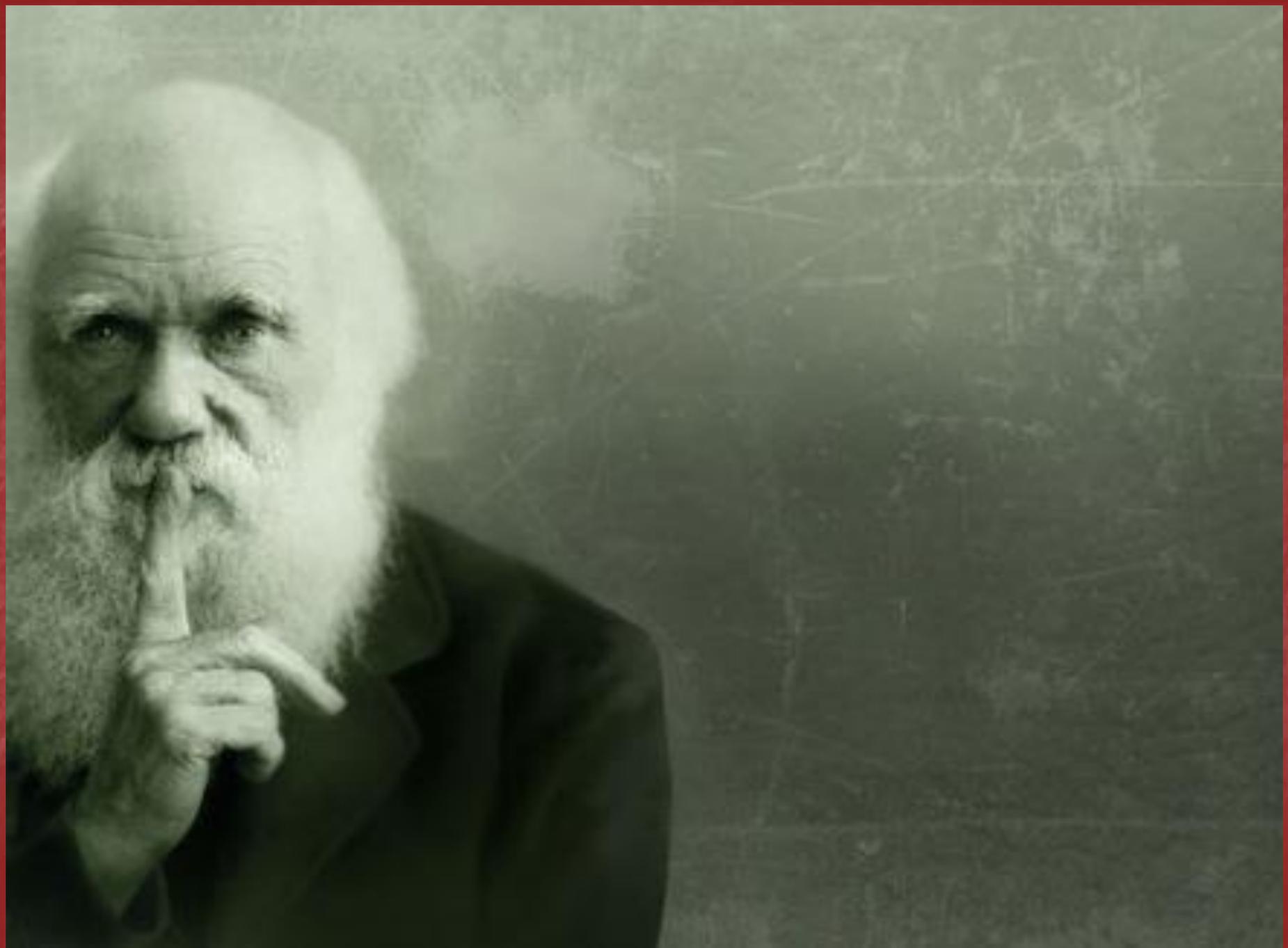
# How does variation lead to evolution?

- As the gene pool changes generation after generation, the species characteristics change or evolve
- As time goes by, the species can undergo changes both minor and major (***descent with modification***), or even become a new species (***speciation***)



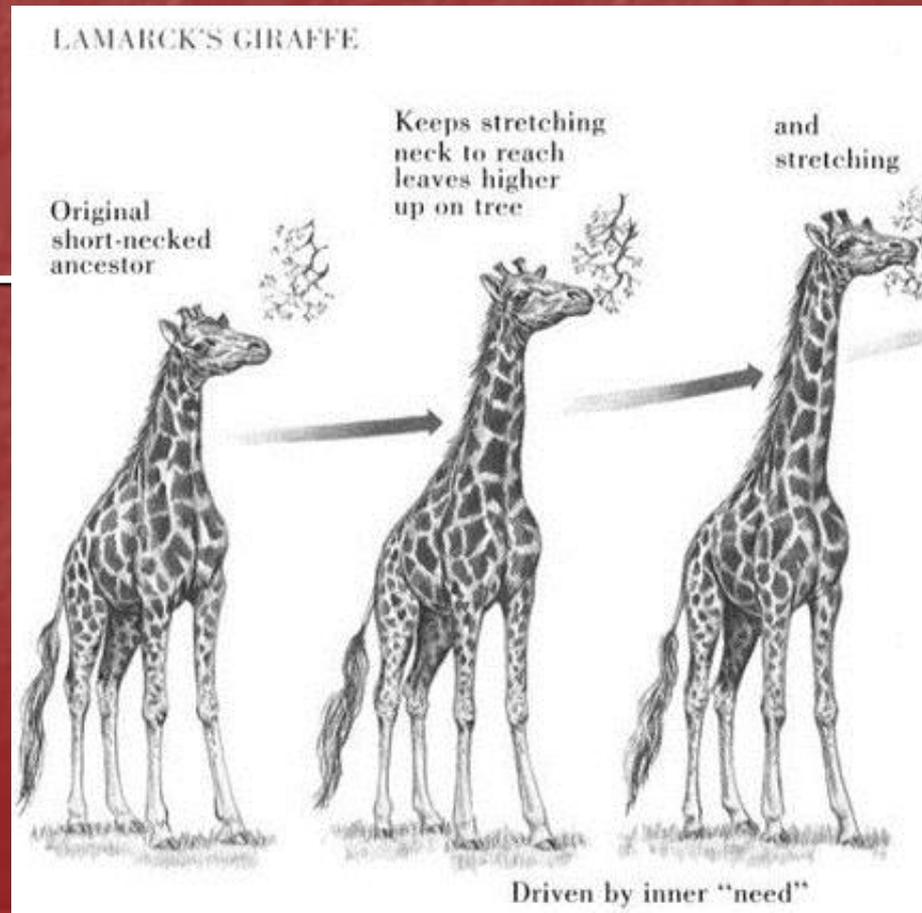
# Adaptive radiation in Galapagos finches





# The influence of other

- Jean-Baptiste Lamarck –
- Theory of inheritance of a



AN  
ESSAY  
ON THE  
PRINCIPLE OF POPULATION,  
AS IT AFFECTS  
THE FUTURE IMPROVEMENT OF SOCIETY.

WITH REMARKS  
ON THE SPECULATIONS OF MR. GODWIN,  
M. CONDORCET,  
AND OTHER WRITERS.

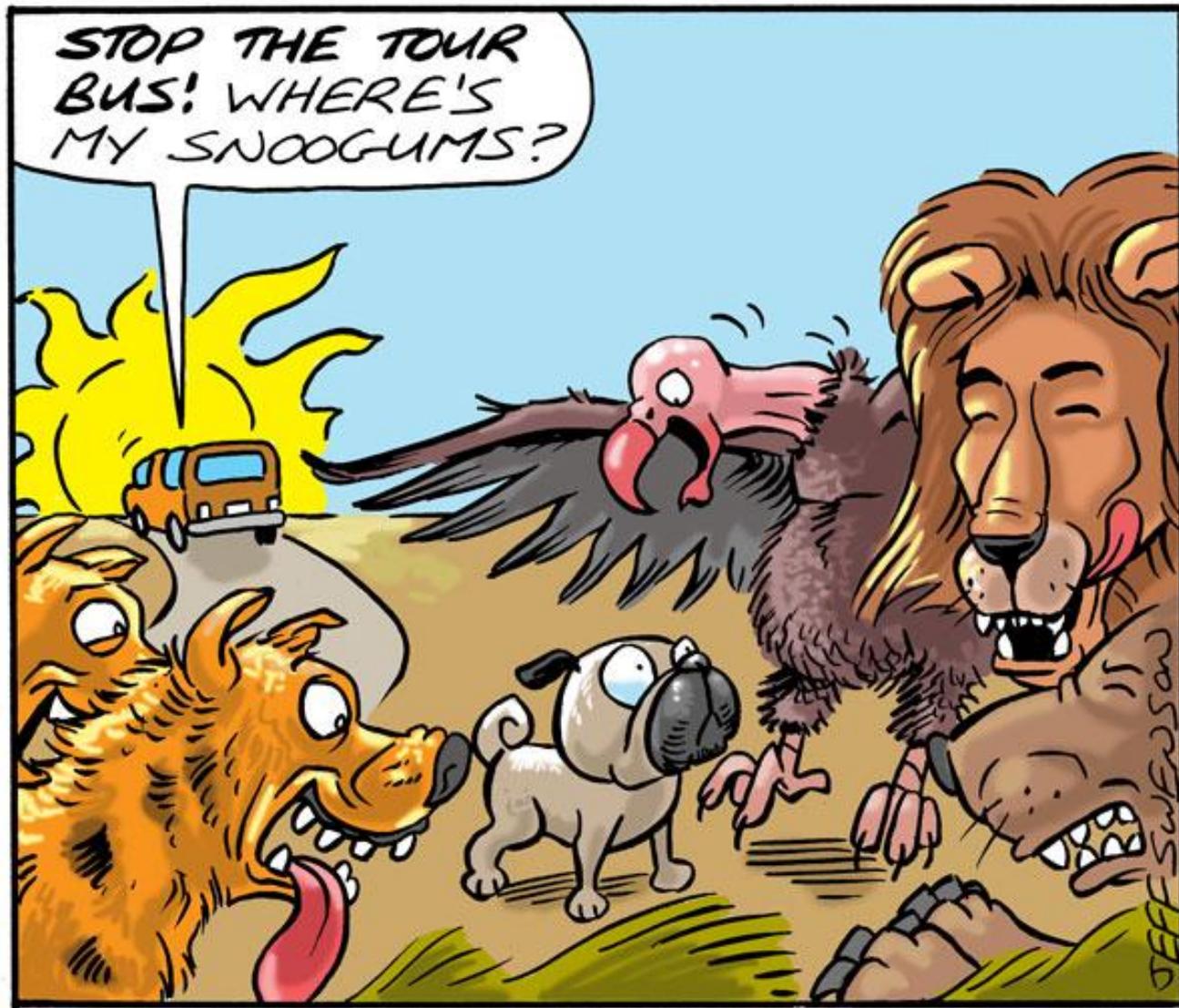
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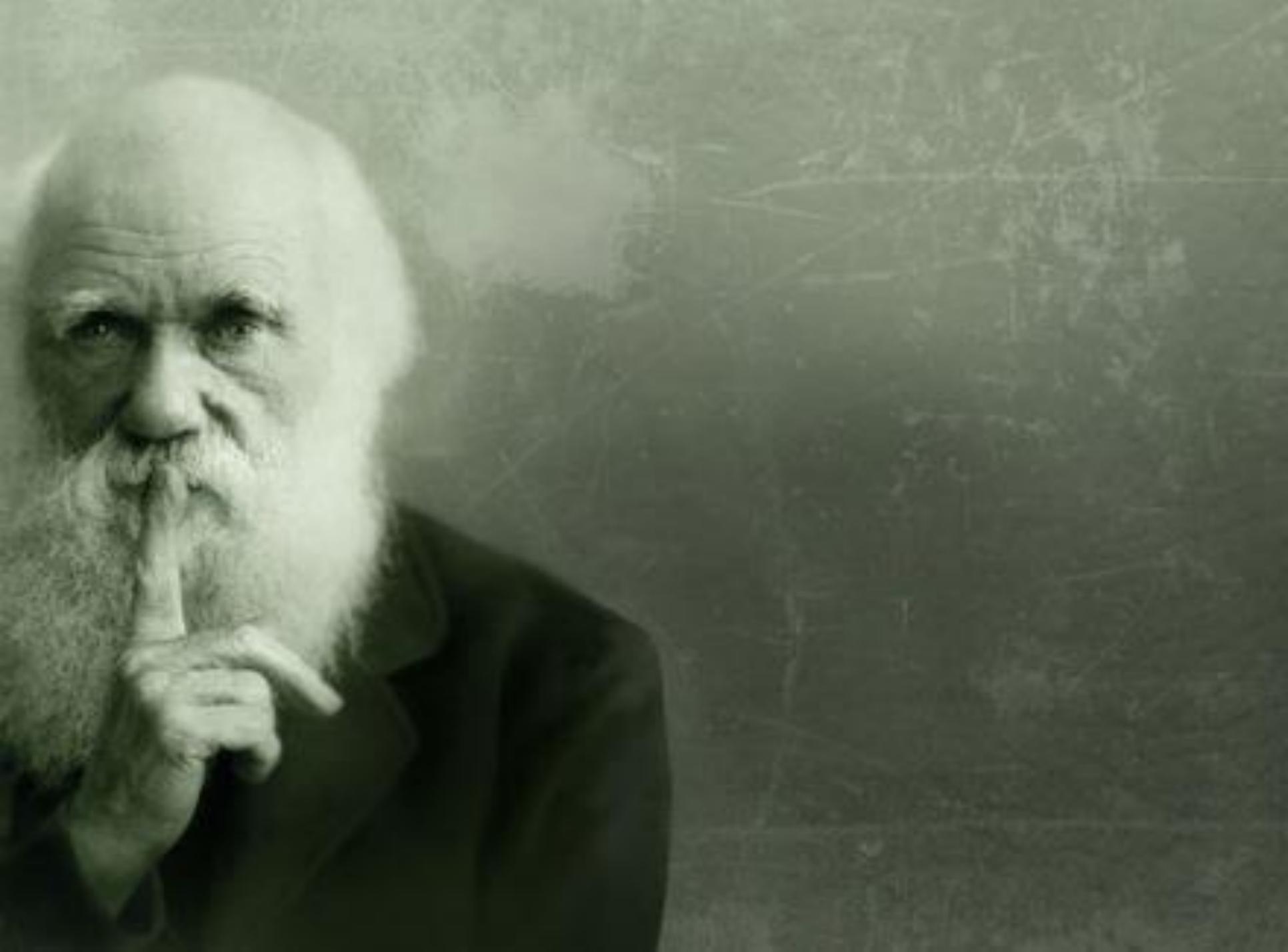
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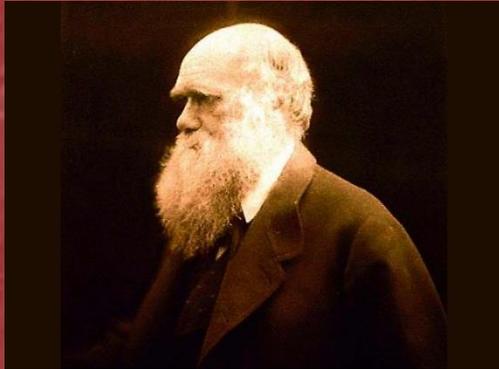
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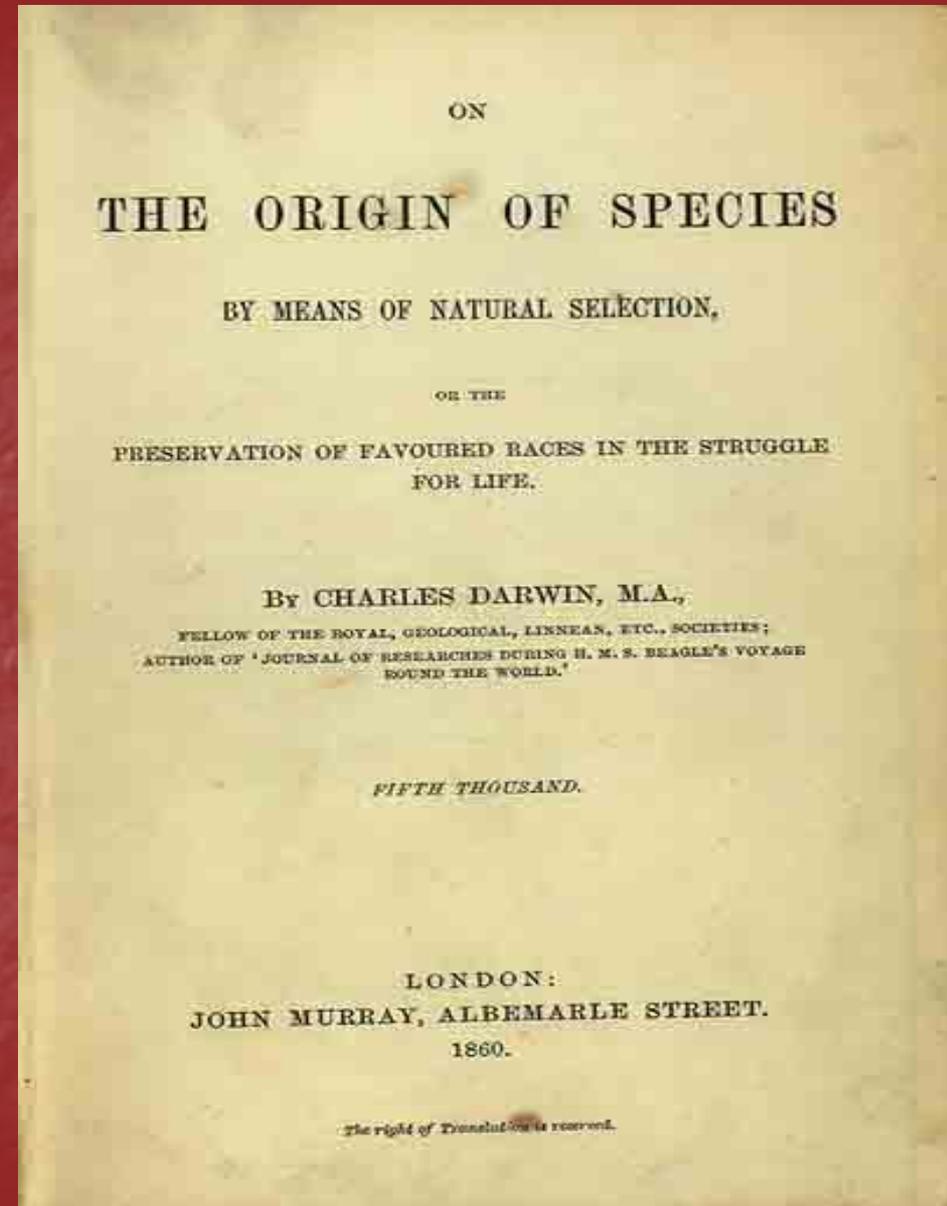
ARTIFICIAL SELECTION MEETS NATURAL SELECTION ON THE AFRICAN PLAINS.



# What is natural selection?



- In 1859, Charles Darwin published his book *On the Origin of Species*, where he explained how species evolve by a process called natural selection



# Darwin's Idea

- Darwin realized that adaptations increase the fitness of an organism
- ***Fitness*** is an organism's ability to survive and reproduce in a specific environment
- Darwin realized that organisms with high fitness were more likely to survive and reproduce

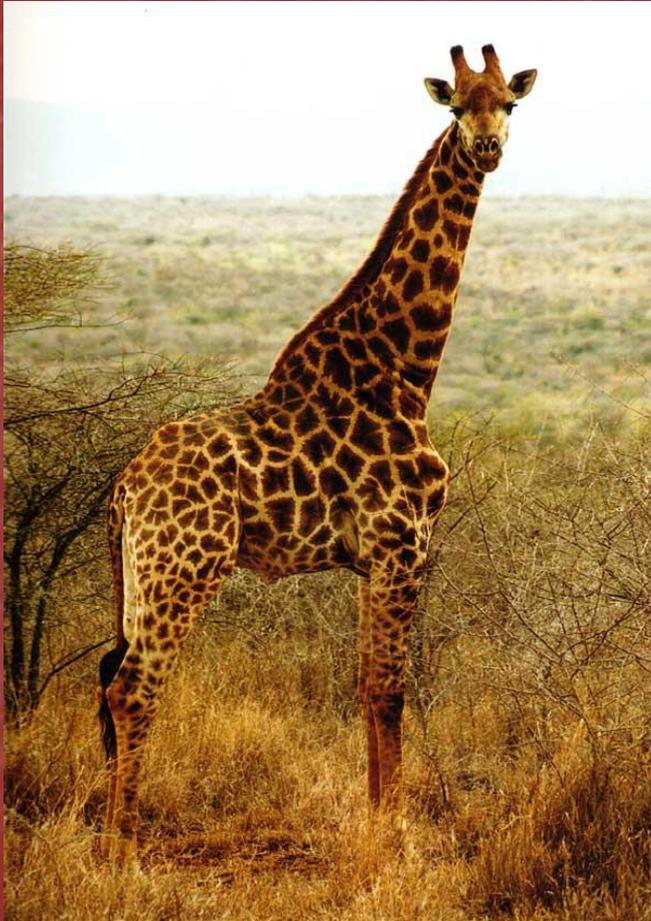
# What is natural selection?

- **Natural Selection** – process where organisms with the best adaptations for their environment survive, reproduce, and pass their genes to the next generation
- Natural selection is a 4-step process:
  1. **Overproduction** – there are more organisms born than the environment can support
  2. **Competition** – organisms compete with other members of the population for resources (food, shelter, water, mates)

# What is natural selection?

3. Survival of the Fittest – organisms in a population are not all the same (variation) - organisms with better adaptations are more successful than organisms without these adaptations so they tend to live longer and reproduce more
4. Passing of Traits – genes that cause adaptations are passed from one generation to the next, changing the gene pool and causing changes in the overall traits of the species (beneficial adaptations appear more frequently)

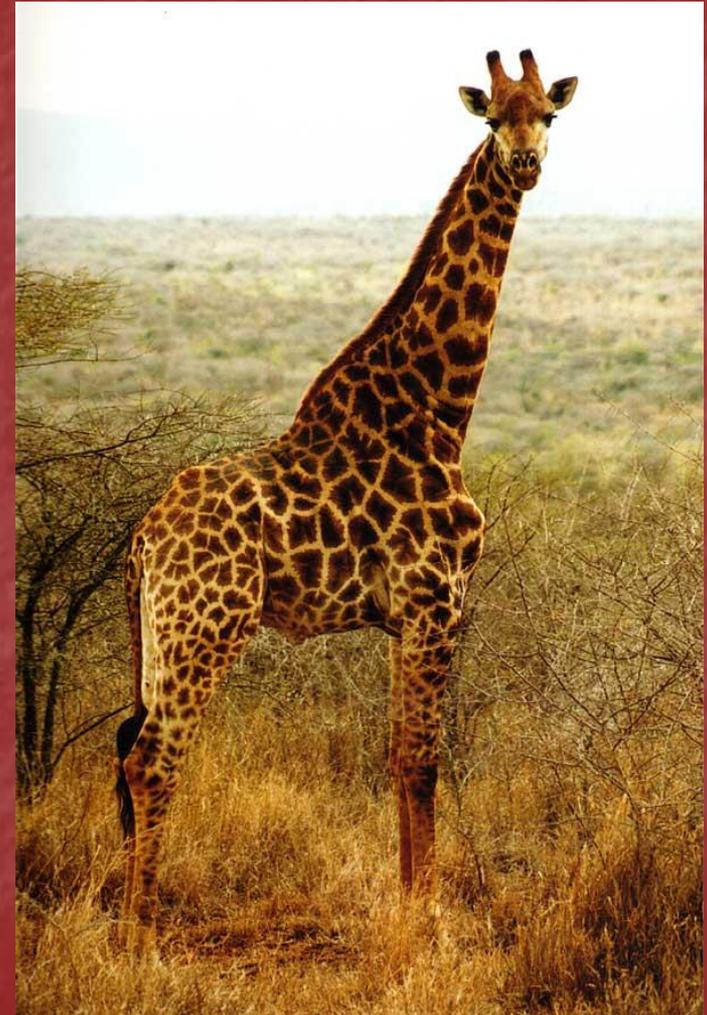
# EX. Giraffes



1. More giraffes are born than the environment can support
2. Giraffes compete for resources
3. The giraffes with the longest necks have a survival advantage, so they survive longer and reproduce more

# EX. Giraffes

4. The genes causing the longest necks are passed on more than the other neck genes, changing the giraffe gene pool and causing the average neck length of giraffes to increase from one generation to the next



# Animal Adaptations



# Types of Adaptation

- Anything that helps an organism survive in its environment is an adaptation.
- It also refers to the ability of living things to adjust to different conditions within their environments.
  - ***Structural adaptation***
  - ***Protective coloration***
  - ***Mimicry***
  - ***Behaviour adaptations***
  - ***Migration***
  - ***Hibernation***

# Structural adaptations

- A **structural adaptation** involves some part of an animal's body.

- Teeth
- Body coverings
- Movement



# Protective Coloration



- **Coloration and protective resemblance** allow an animal to blend into its environment.
- Another word for this might be camouflage. Their camouflage makes it hard for enemies to single out individuals.



# Mimicry

- **Mimicry** allows one animal to look, sound, or act like another animal to fool predators into thinking it is poisonous or dangerous.



# Behaviour adaptations



- **Behaviour adaptations** include activities that help an animal survive.
- Behaviour adaptations can be learned or instinctive.
  - Social behaviour
  - Behaviour for protection



# Migration

- This is when behavioral adaptation that involves an animal or group of animals moving from one region to another and then back again.



- Animals migrate for different reasons.
  - better climate
  - better food
  - safe place to live
  - safe place to raise young
  - go back to the place they were born.

# Hibernation

- This is deep sleep in which animal's body temp droops, body activities are slowed to conserve energy.
- E.g. Bats, woodchucks & bears.



# Remember...

- Individuals DO NOT EVOLVE
- Species populations evolve when traits are passed from one generation to the next in an unequal way, which makes some traits appear more than others in the next generation
- Over time, natural selection results in changes in the inherited characteristics of a population, which increases a species' fitness in its environment
- Over many generations, this can lead to large changes in the overall traits of a species population, and even create new species