Natural Selection

With the scary-looking giraffes

1. NATURAL SELECTION

"Survival of the fittest"

Natural selection is a way of explaining how **EVOLUTION** happens: through the struggle for resources and differential survival, allowing some individuals to pass on their genes but not others.

Evolution is the change in **HERITABLE** characteristics in a **POPULATION** over **TIME**.

Passed On Genetically

Not on an individual level

Does Not Happen Overnight

[Representing the average giraffe of its time]

There are **5** steps to the process of Natural Selection:

1. Overproduction of offspring
2. Variation within the population
3. Struggle for survival
4. Differential survival
5. Reproduction

1. OVERPRODUCTION OF OFFSPRING

Lots of resources are available, and not many giraffes (little competition) leads to many babies (offspring).
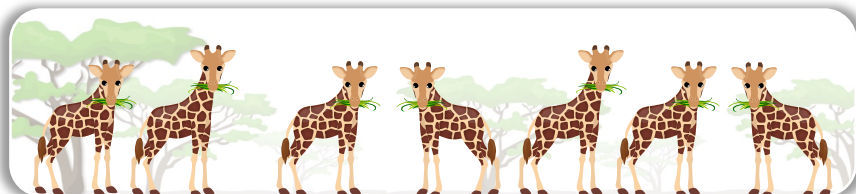
✓ Water
✓ Space
✓ Nutrients
✓ Sunlight

Lots of babies (offspring)

CARRYING CAPACITY
The maximum number of individuals that an environment can provide for.

Resources are factors which may limit the carrying capacity: fewer resources reduces the carrying capacity of an environment.

2. VARIATION WITHIN THE POPULATION

In a population of giraffes there exists **genetic variation**. Giraffes will have differing neck lengths due to their genetics. Genetic variation between individuals of a population exists because of the following three reasons:

Allele
Version of a gene

Gene #1
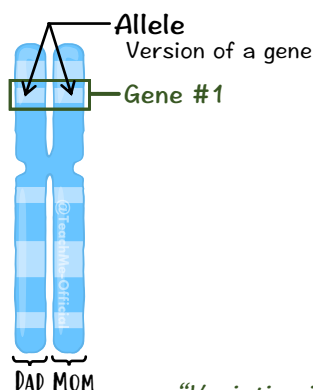
(1) Mutations in DNA more about mutations in D1.3
Some gene mutations have no effect, some a bad effect and some a good effect.
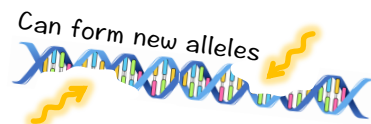
Can form new alleles

(2) Meiosis more about meiosis in D2.1
Makes gametes that are genetically different from each other (INDEPENDENT ASSORTMENT and CROSSING OVER).
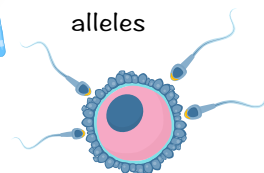
Forms new combinations of alleles

(3) Random gamete fusion more about fertilization in D3.1
Random combination of sperm and egg results in an organism with a unique genetic combination.

DAD MOM

"Variation in a population ensures that during a change in the environment only some will be eliminated, and some will be genetically adapted to overcome that change"
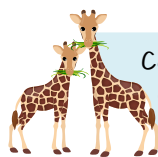
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As you can see, asexually reproducing organisms will be at a disadvantage as less variation can be produced.

Natural Selection

3. Struggle for survival

<u>SELECTION PRESSURES</u> will act on the population.

A FACTOR that can influence the SUCCESS of a population.
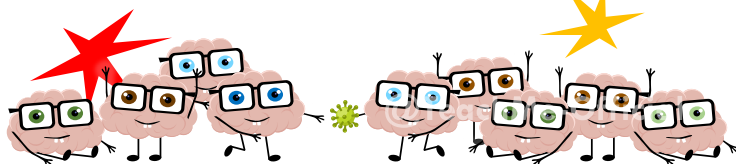(Survival & Reproduction)

Competition between individuals of the same species is called INTRASPECIFIC competition.

Density independent factors (abiotic):

Ones that affect the population no matter how big or how small the population is.
For example, acidity of the ocean will be as harmful to a large coral reef as it will be to a small one.

Density dependent factors (biotic):

ESPECIALLY IMPORTANT IN NATURAL SELECTION!

Ones that affect a population more when the population numbers are higher.
Example; Disease spreads faster in highly populated area.

Big Brain Tip!
🐾 PANDA PAW

Density Dependent factors
Predators
Availability of recources
Nutrient supply
Disease
Accumulation of waste

Density Independent factors
Phenomena
Abiotic factors
Wheather conditions

In the case of our giraffes, nutrition can be a density dependent factor that is competed for. Due to genetic variation, different giraffes will have slightly different neck lengths. The larger the population gets the more the individuals have to compete for the nutrition on the trees. Those with longer necks are able to reach higher in the trees and therefor be at a competitive advantage compared to those with shorter necks.

4. Differential Survival

Survival of the FITTEST

- **High fitness**: Well adapted for environment.
- **Low fitness**: Not as well adapted for the environment.
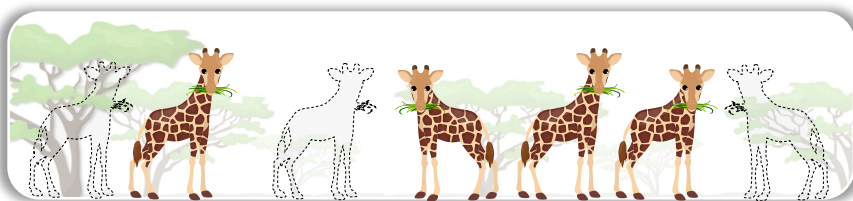
Those with shorter necks struggle to reach higher leaves, and thus are more likely to die than those with longer necks, which are more likely to survive.

5. Reproduction by the survivors

Organisms that survive are more likely to REPRODUCE.

Fit individuals have better chance of competing successfully with other members, reproducing and passing on their successful genetic characteristics, their genotype, to the next generation.

Over many generations, the accumulation of changes in the heritable characteristics of a population results in evolution.

In our giraffe example, the longer neck giraffes are more likely to survive, and therefor more likely than the shorter neck giraffes to pass on their genetics (or favorable alleles) to the next generation.
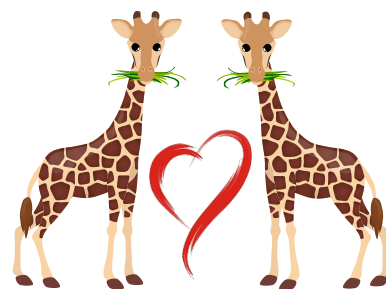
"Natural selection can modify the frequency of alleles in a population over time".
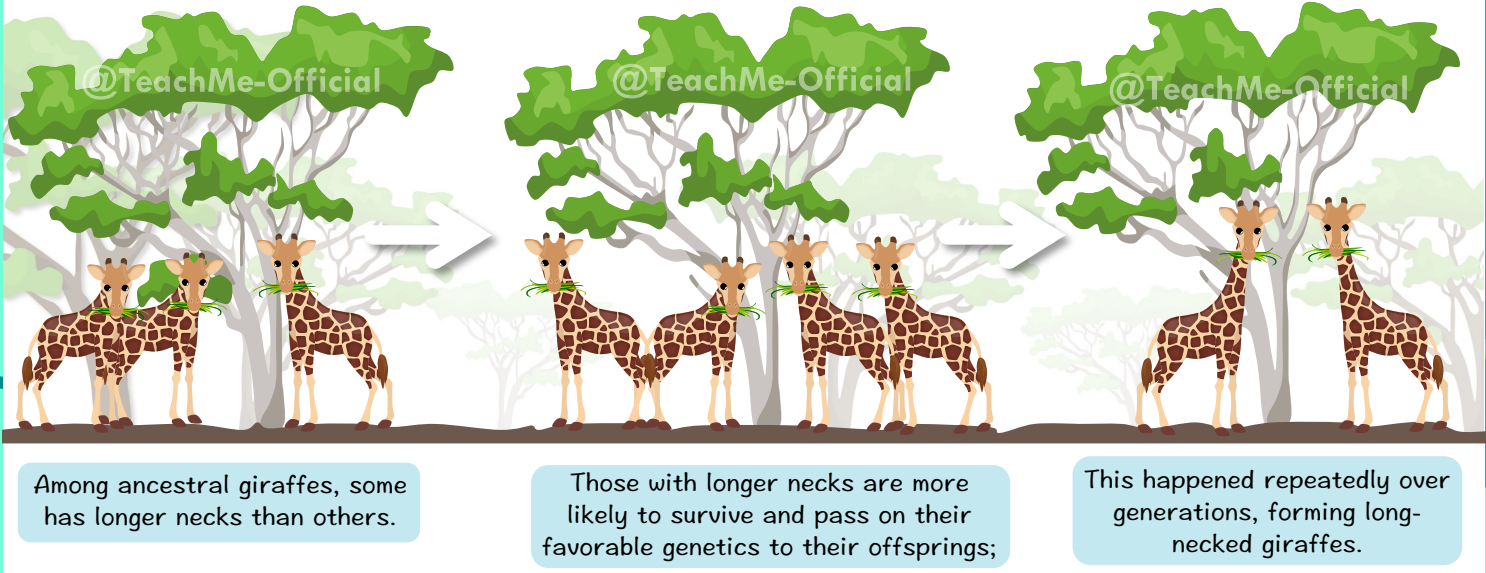
Natural Selection

II. Lamarckism & Darwinism

Darwinism

A theory of evolution through natural selection.

By **Charles Darwin** and **Alfred Russel Wallace**

Among ancestral giraffes, some has longer necks than others.

Those with longer necks are more likely to survive and pass on their favorable genetics to their offsprings;

This happened repeatedly over generations, forming long-necked giraffes.

Lamarckism (prior to Darwinism)

By **Lamarck**

Organism's aquired characteristics through their lifetime and passed them on to their offsprings.

The ancestral giraffes stretched their necks to reach leaves.

The offsprings inherited the aquired streched necks.

This happened repeatedly over generations, forming long-necked giraffes

A Paradigm shift occurred, and the accepted theory of evolution changed from Lamarck's to Darwin's.

Natural Selection

III. HERITABLE VS. ACQUIRED TRAITS

ACQUIRED TRAIT

HERITABLE TRAIT

A trait that is encoded in the organisms DNA. It can be passed on to the next generation.

A trait that is earned during the lifetime. It is not coded in the DNA. They only affect the individual and not their offspring. These do not result in evolutionary changes.
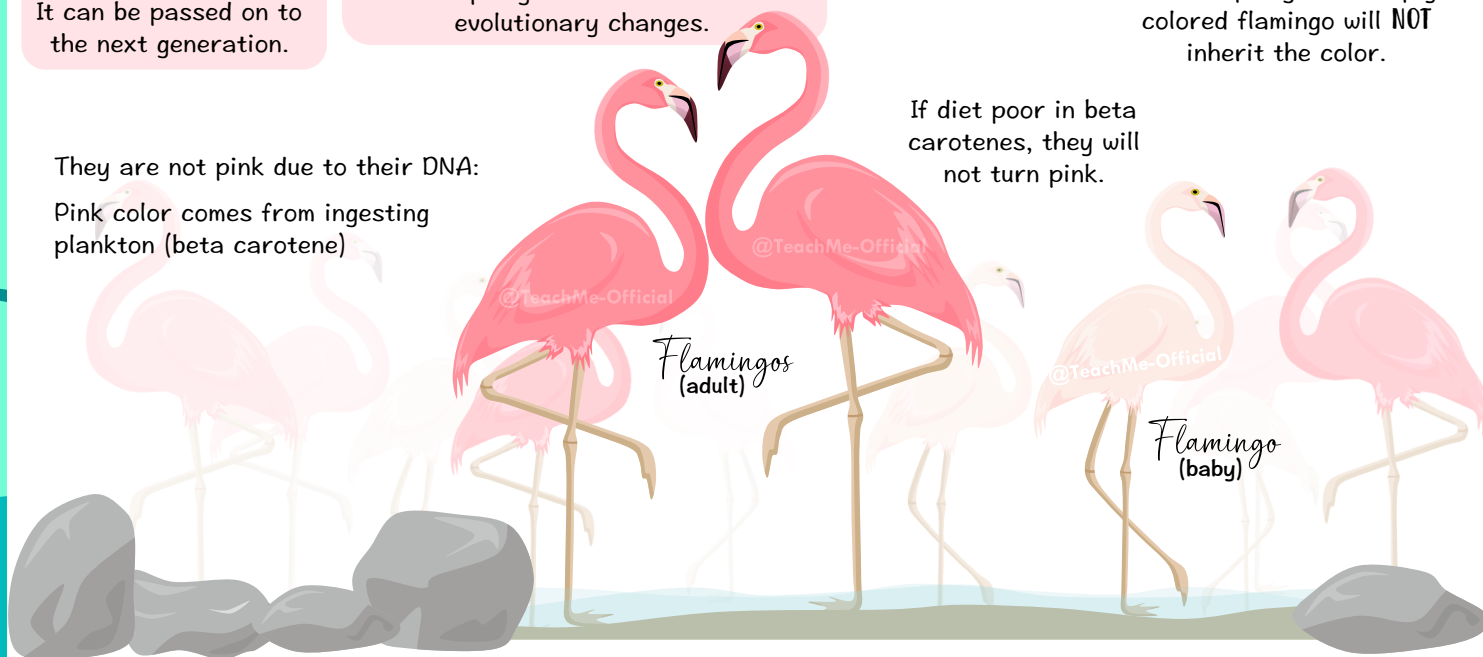
BETA CAROTENE contributes to the coloration of carrots, sweet potatoes...

The offspring of a deeply colored flamingo will **NOT** inherit the color.

They are not pink due to their DNA:

Pink color comes from ingesting plankton (beta carotene)

If diet poor in beta carotenes, they will not turn pink.

Flamingos
(adult)

Flamingo
(baby)

IV. MODELING SELECTION PRESSURES

John Endler
1970s
Experiments on Guppies

Guppies (species of fish) are a great example to illustrate selection pressures within a species.

They show **sexual dimorphism** — Morphological difference between males and females.

Hypothesis:

Guppies in pools protected from predatory fish would show more ornate colors, whereas those in pools where predators were present would be less colorful because their ability to hide would lead to better chances of survival.
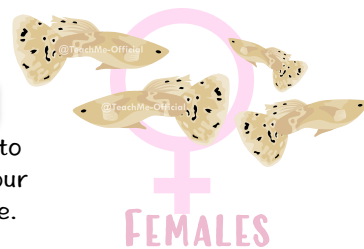
SEXUAL SELECTION

Survival and the ability to reproduce depends on your ability to attract a mate.
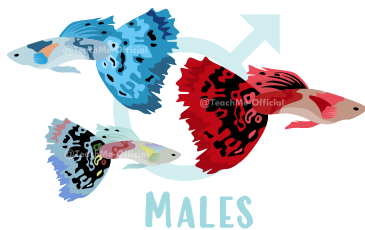
MALES

Males have **GENES** that allow them to **DISPLAY COLOR.**

Different males could display different colors

FEMALES

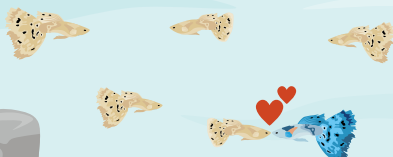Females show **CRYPTIC COLORATION** (for camouflage).

Intersexual competition — competition between males for access to females.

Over many generations, guppies show more ornate colors as it is advantageous to them to attract females: allowing the trait to be passed on to the offspring.
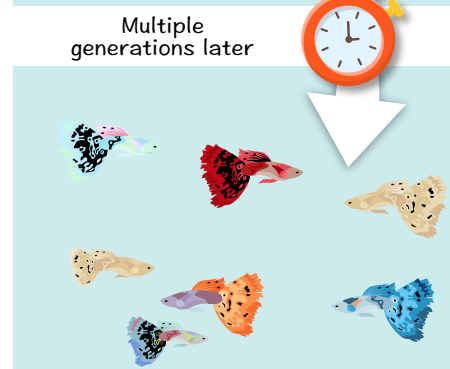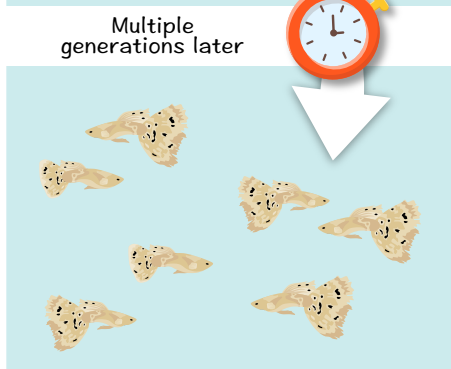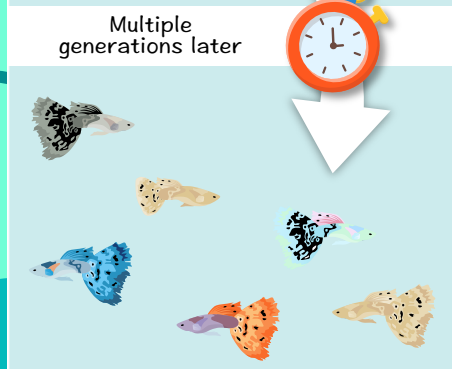
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An experiment set up by John Endler also demonstrated the presence of predation pressure in determining the frequency of ornate colors in the guppies.

PREDATION PRESSURE Survival and the ability to reproduce depends on your ability to overcome predators.

No predator

C. alta
DANGEROUS PREDATOR

R. Hartii
LESS DANGEROUS PREDATOR

Multiple generations later

Multiple generations later

Multiple generations later

[It was noticed that in the presence of a dangerous predator the guppies that were cryptic (dull) colored were less likely to be spotted and therefor more likely to survive and pass on their genetics.]

Overall, guppies coloring is influenced by both SEXUAL SELECTION PRESSURE and PREDATION PRESSURE:

❖ Males need to stand out to attract the females.

❖ High fitness means they show **BRIGHT CONSPICUOUS COLORS** to stand out against the background.

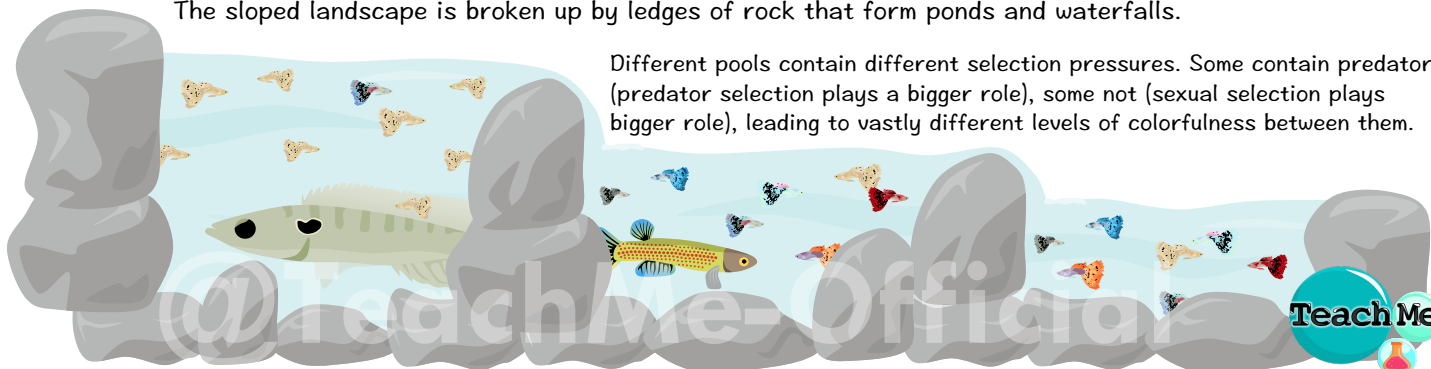❖ **ALLELE FREQUENCY** for bright colors **INCREASE** over time.

SEXUAL SELECTION PRESSURE

PREDATION PRESSURE
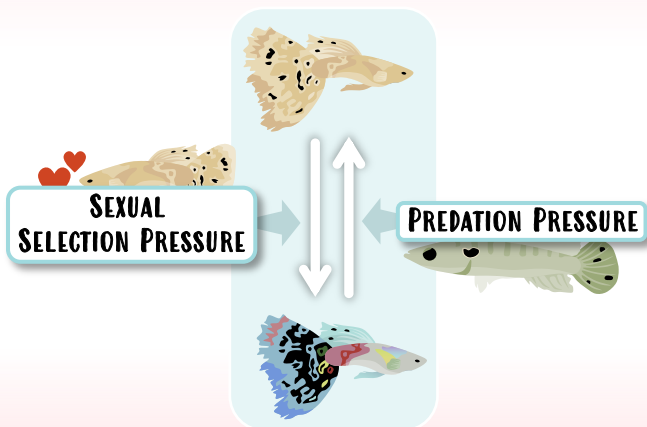
❖ Ornate or brigtly colored males tend to be more easily noticed by predators.

❖ High fitness means they show **CRYPTIC COLORS** to blend with the background.

❖ **ALLELE FREQUENCY** for bright colors **DECREASES** over time.

In nature, guppies thrive on Trinidad island (off the coast of Venezuela).

The sloped landscape is broken up by ledges of rock that form ponds and waterfalls.

Different pools contain different selection pressures. Some contain predators (predator selection plays a bigger role), some not (sexual selection plays bigger role), leading to vastly different levels of colorfulness between them.

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Notes