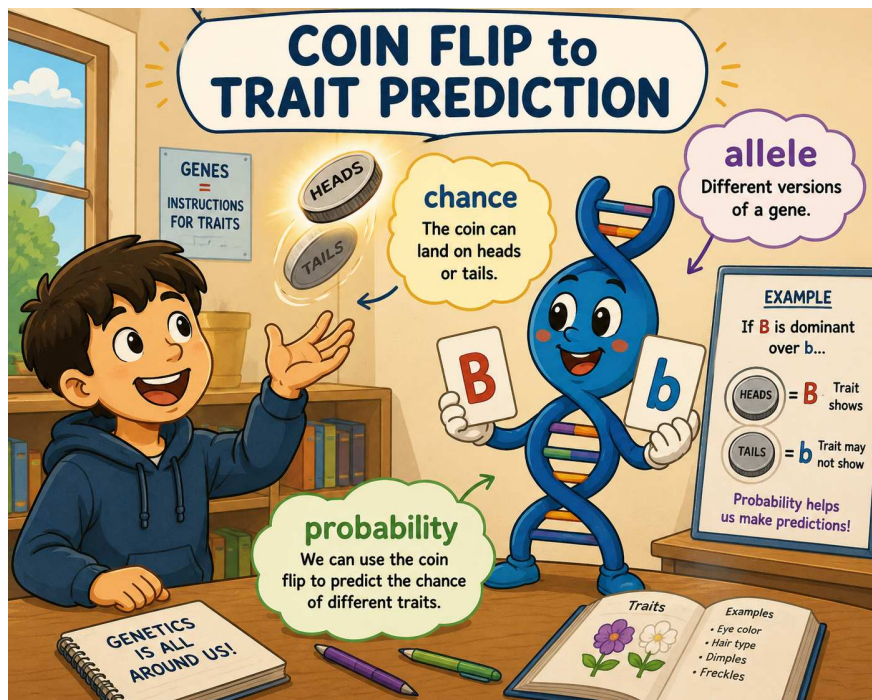


Topic 3.3 How is genetic information passed on, and how can populations change over time?

Punnett squares show the probability of traits



Vocab	What it means
chance	the coin can land on heads or tails
allele	different versions of a gene
probability	we can use the coinflip to predict the chance of different traits

Easy explanation

Probability means chance.

A coin flip has two possible results.

Heads or tails.

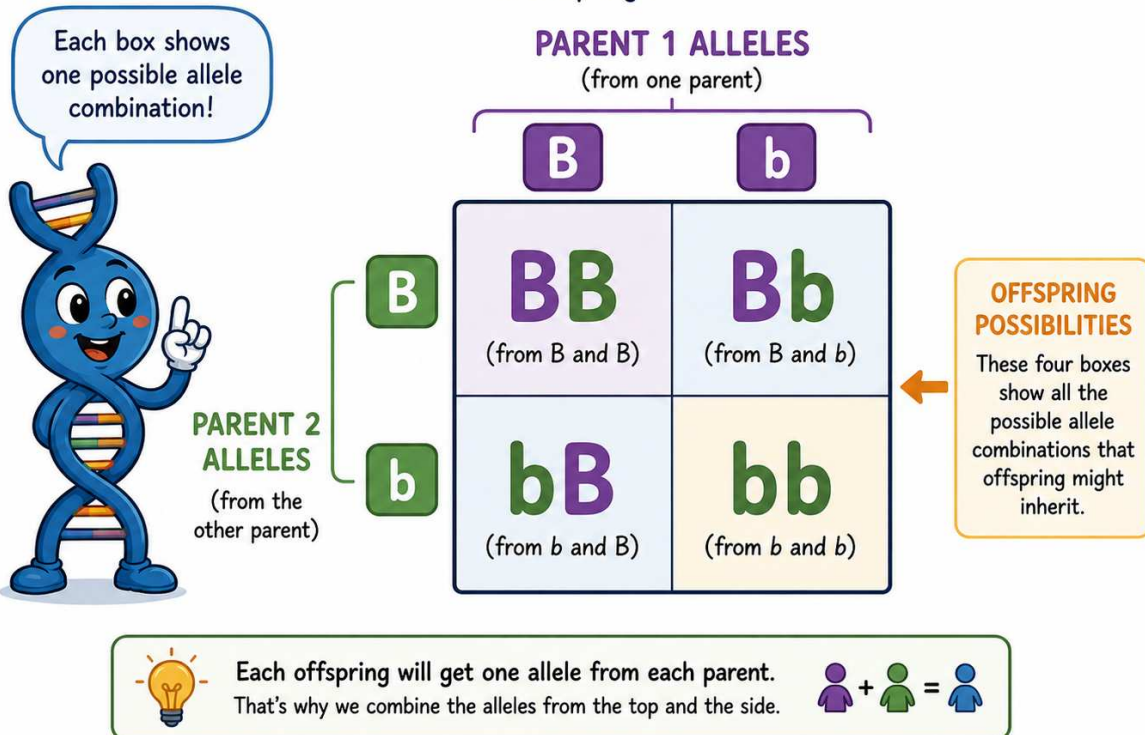
Alleles also have possible combinations.

A **Punnett square** helps **predict those combinations**.

What Is a Punnett Square?

ALLELE GRID BOX

We can use a grid to predict the possible allele combinations of offspring.



Easy Explanation

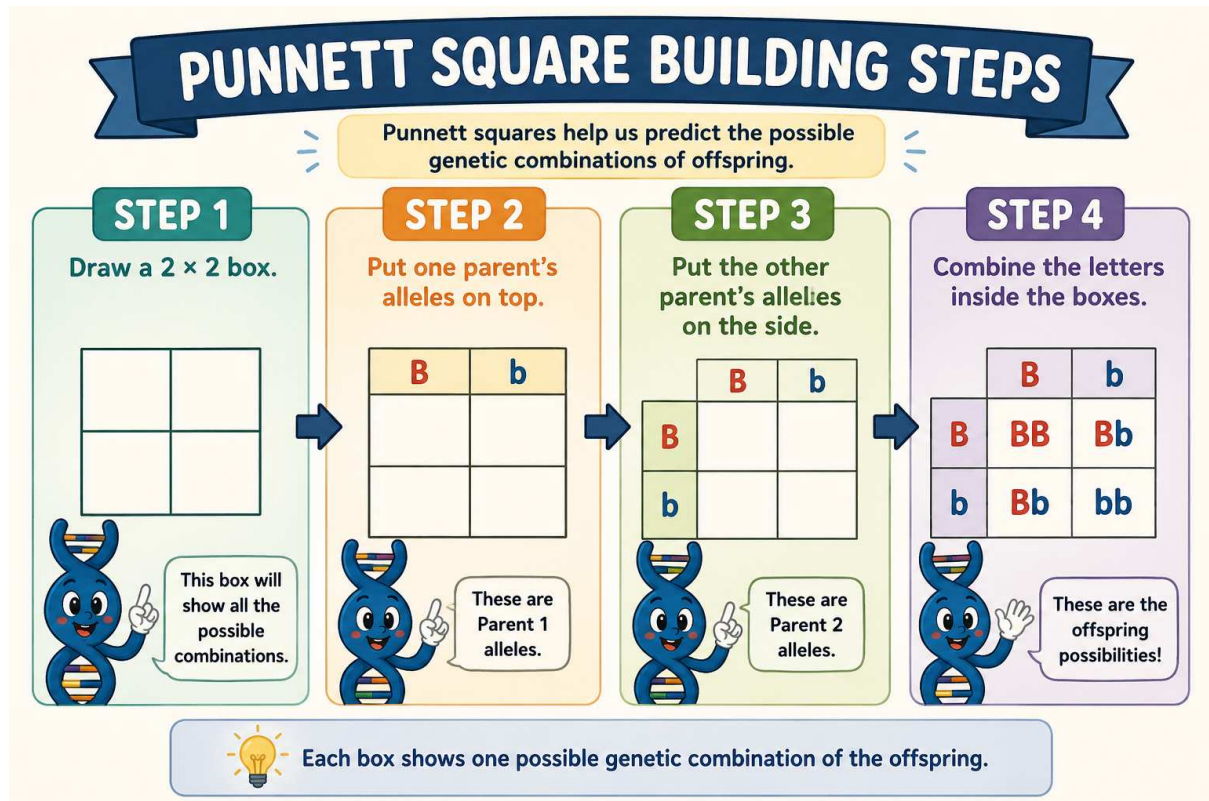
A Punnett square is a prediction tool.

It shows possible allele combinations.

The top (purple letters) shows alleles from one parent.

The side (green letters) shows alleles from the other parent.

How to Fill a Punnett Square



Easy Explanation

Step 1: Draw a box with four squares.

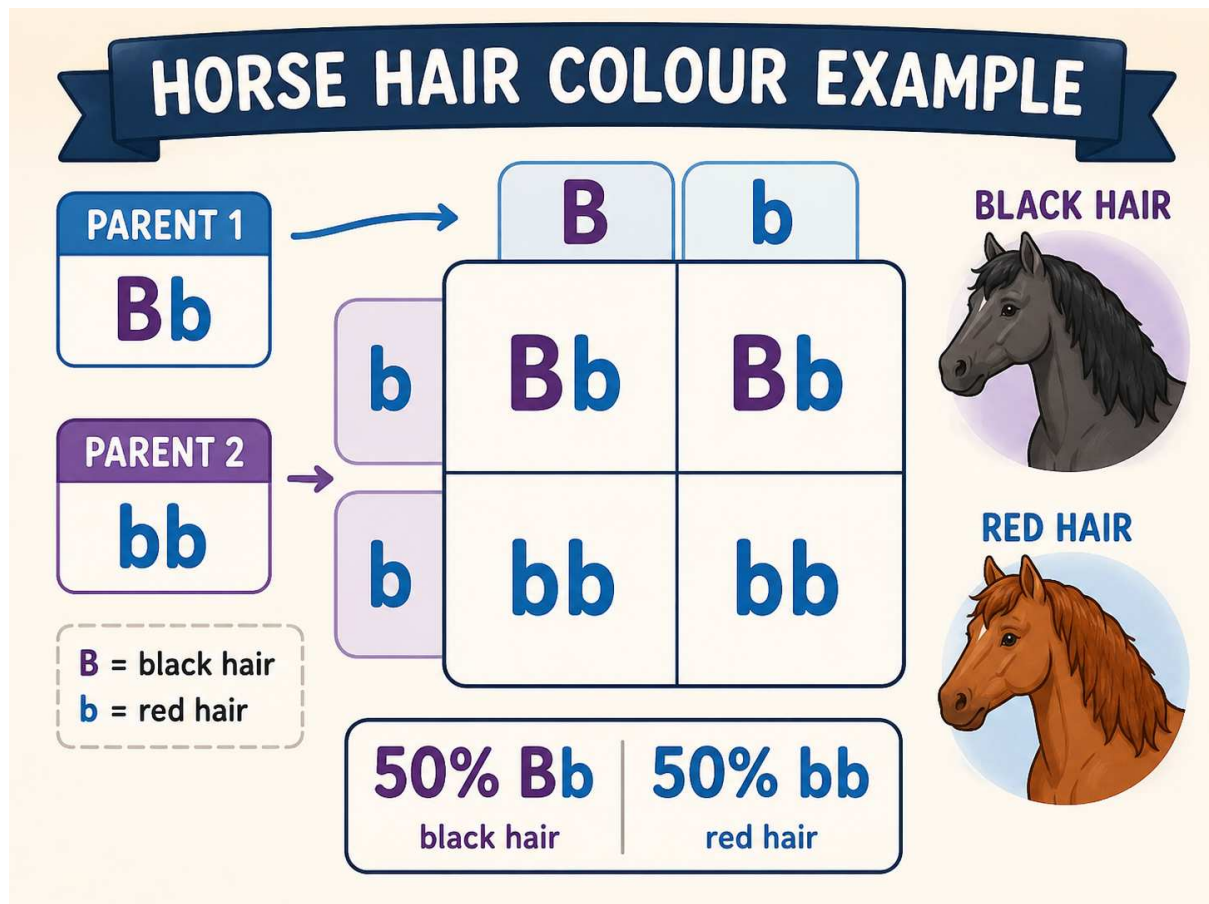
Step 2: Write one parent's alleles (letters) on top.

Step 3: Write the other parent's alleles (letters) on the side.

Step 4: Combine the letters in each square.

Each square is one possible genotype.

Example: Bb × bb



Explanation

B = black hair allele.

b = red hair allele.

B is dominant.

b is recessive.

Bb shows black hair.

bb shows red hair.

This cross predicts:

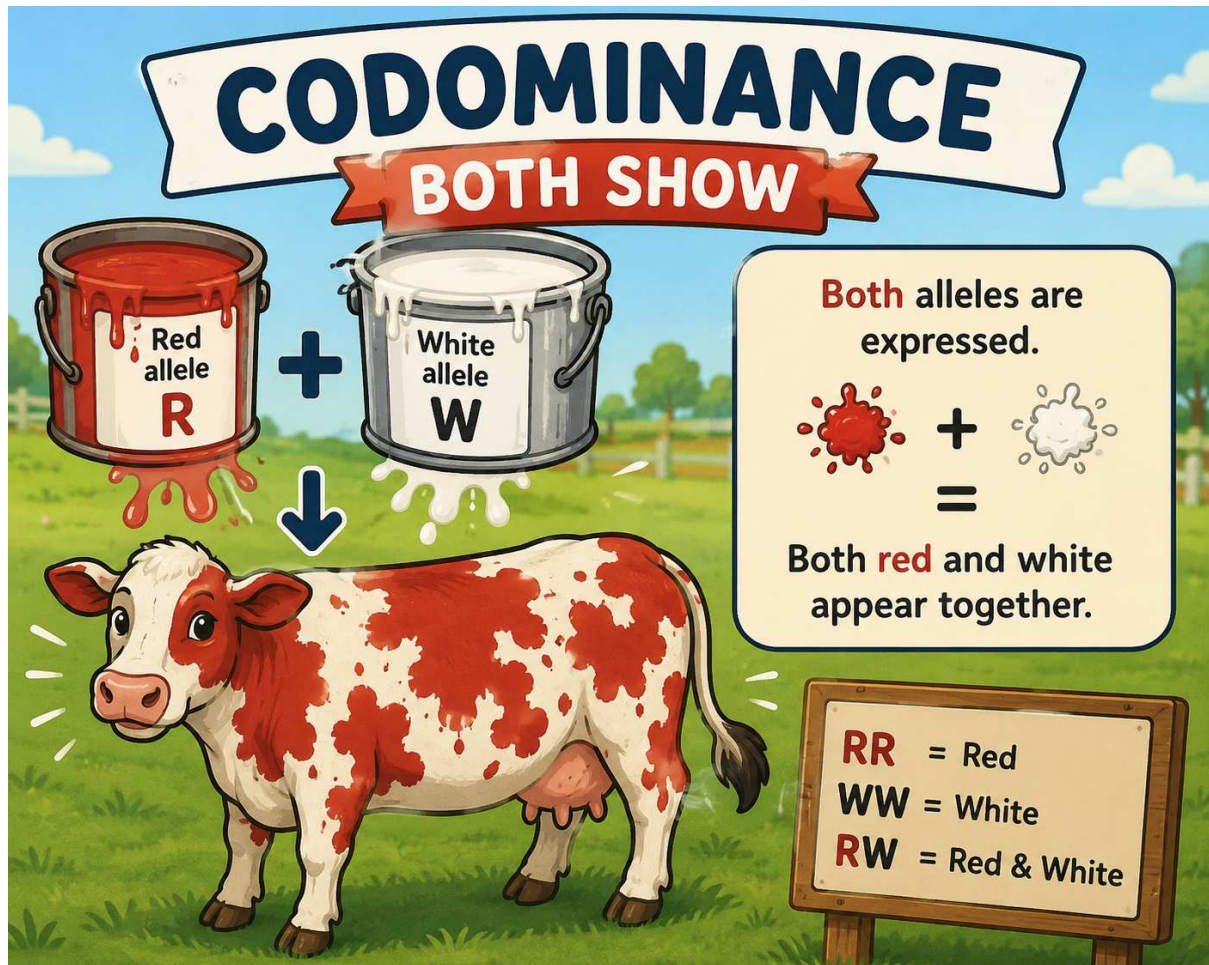
50% Bb

50% bb

So half may show black hair.

Half may show red hair.

Codominance: Both Alleles Show



Vocab	What it means
Dominance	Only one alleles are expressed BB → B (loud) Bb → B (loud) bb → b (quiet)
Codominance	Both alleles are expressed RR → R (red) WW → W (white) RW → RW (red + white at the same time)

Easy Explanation

In codominance, both alleles show.

One allele does not hide the other.

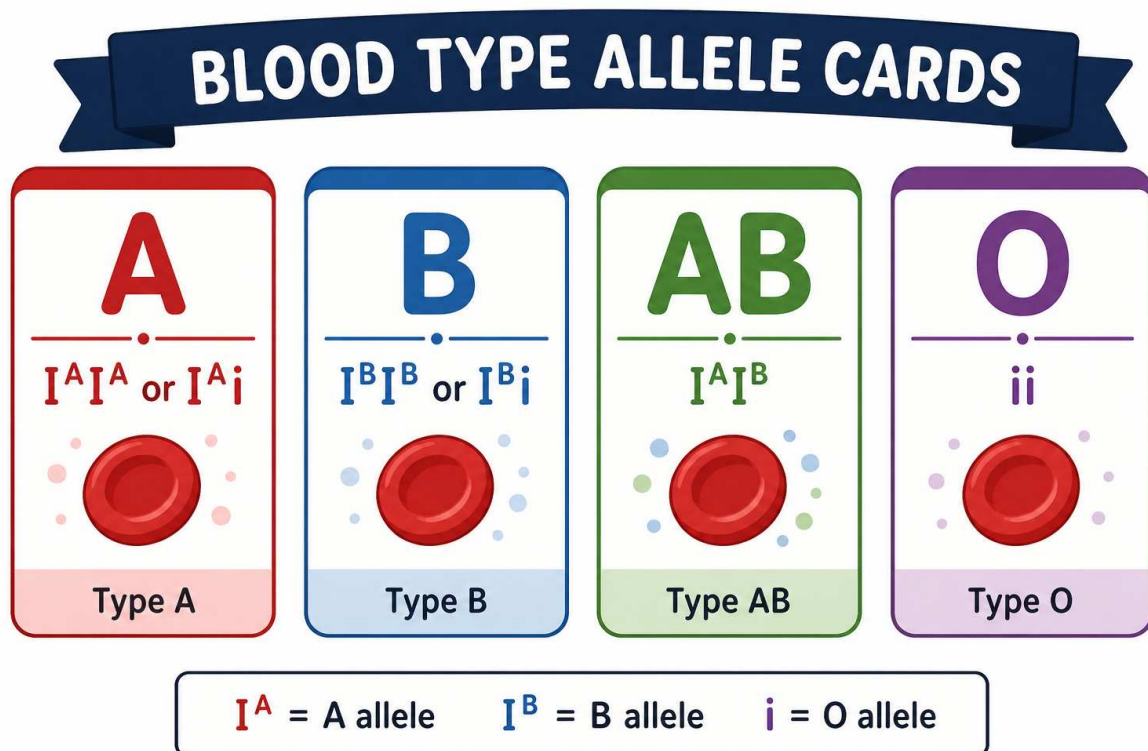
Example:

Red hair allele + white hair allele

Both red and white hairs appear.

This can make a roan animal.

Codominance Example: Blood Type



Easy explanation

Blood type is controlled by alleles.

A and B are codominant.

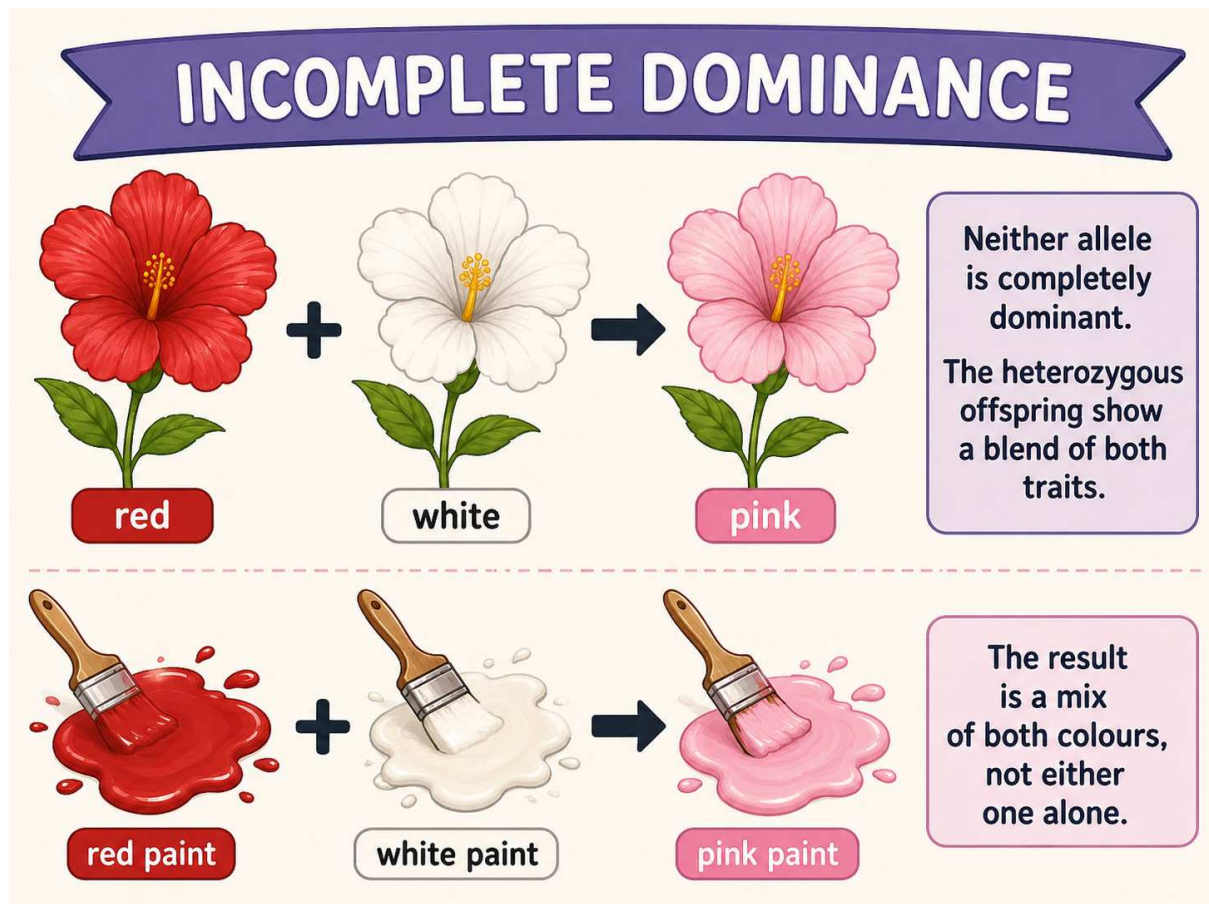
That means both can show together.

Type AB shows both A and B.

O is recessive.

Type O appears when the genotype is ii .

Incomplete Dominance: Blended Trait



Vocab	What it means
Incomplete dominance	neither allele fully dominates *Both alleles are not strong enough to be alone when they are together → they get mixed

Easy Explanation

In incomplete dominance, neither allele fully hides the other.

The heterozygous trait is in between.

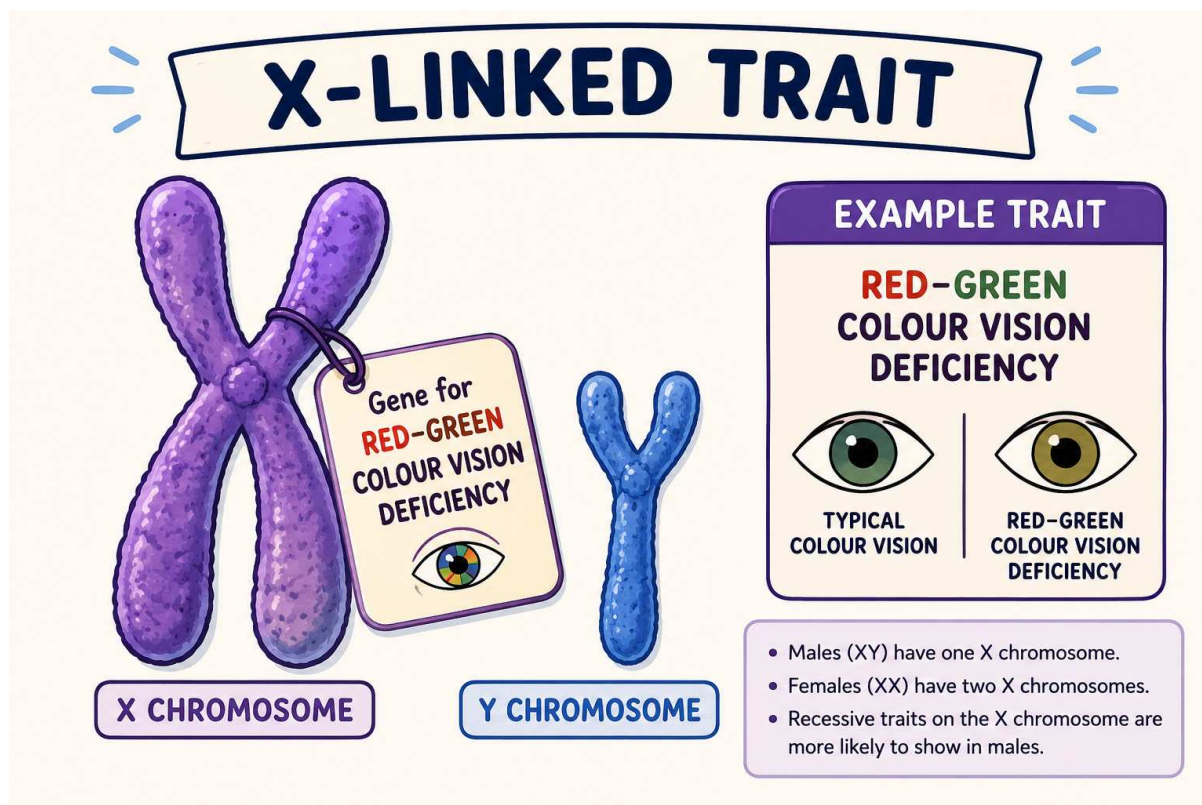
Example:

Red flower × white flower → The offspring can be pink. → Pink is the blended phenotype.

Compare Box

Pattern	What happens?	Heterozygous Example
Dominance	one allele hides another	Bb = loud (one trait)
Codominance	both alleles show	AB blood (two traits at the same time)
Incomplete dominance	alleles blend	RW = pink (two traits mixed)

Sex-Linked Traits



Vocab	What it means
sex-linked traits	some genes found on sex chromosomes
Males	X and Y chromosome
Females	X and X chromosome

Easy explanation

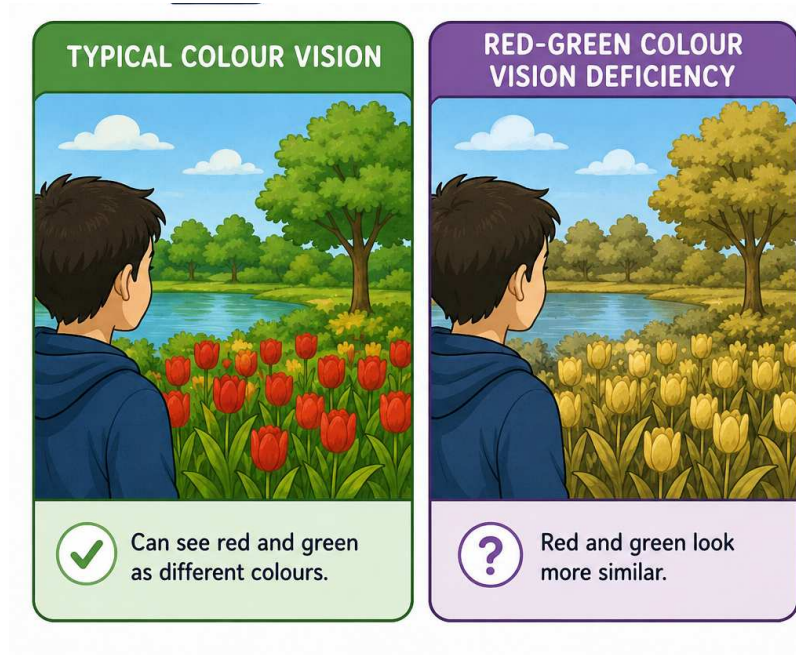
Many sex-linked traits are on the X chromosome.

Males usually have one X and one Y.

Females usually have two X chromosomes.

Because males have only one X, **recessive X-linked traits can show more often in males.**

Colour Vision Example

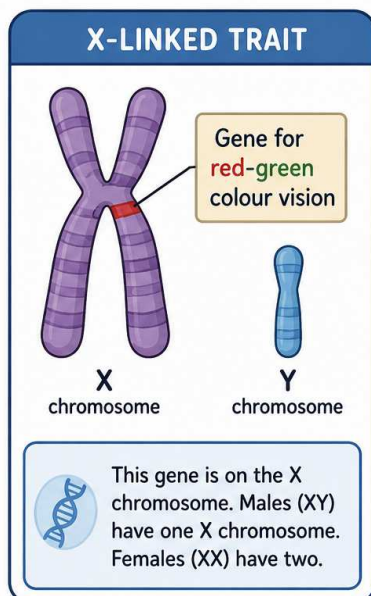


Easy explanation

Some people have difficulty seeing red and green as different colours.

This can be caused by an X-linked recessive allele.

A male with the recessive allele on his X chromosome will show the trait.

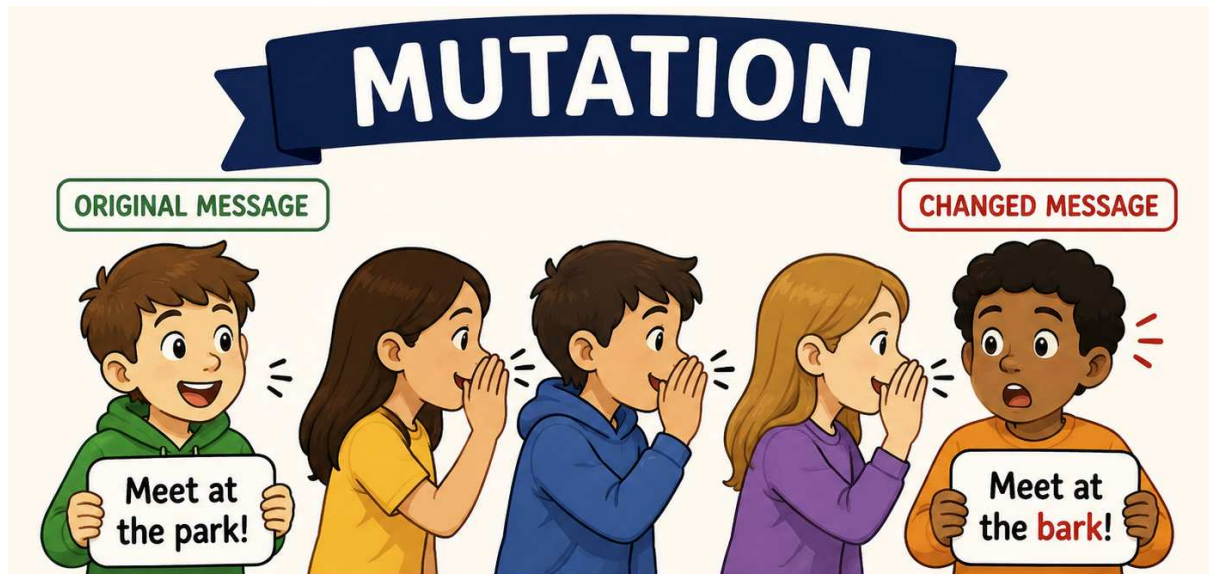


Red-green colour vision deficiency as X-linked recessive trait.

A male with the recessive allele on his X chromosome will show the trait.

A female may be a carrier if one X has the allele and the other X does not.

Mutation, Selection, and Population Change



Vocab	What it means
Mutation	permanent change in DNA

Easy explanation

A mutation is a change in DNA.

Sometimes the change is small.

Sometimes it can affect a trait.

Mutations can happen when DNA is copied.

Mutations can also be caused by environmental factors.

Key Point

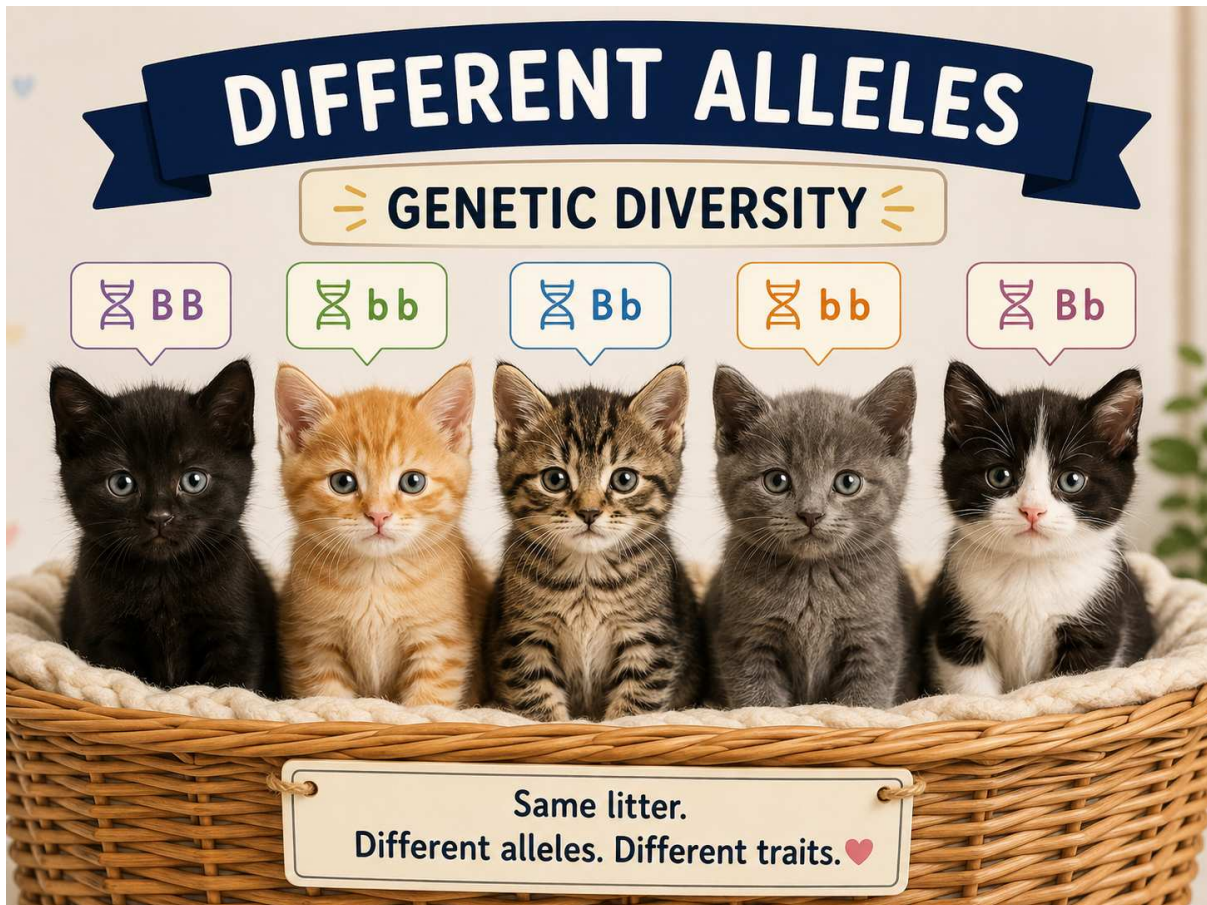
Not all mutations are harmful.

Some are harmful.

Some have no effect.

Some can be helpful.

Mutation Creates Genetic Diversity



Easy explanation

Members of the same species can look different.

This is genetic variation.

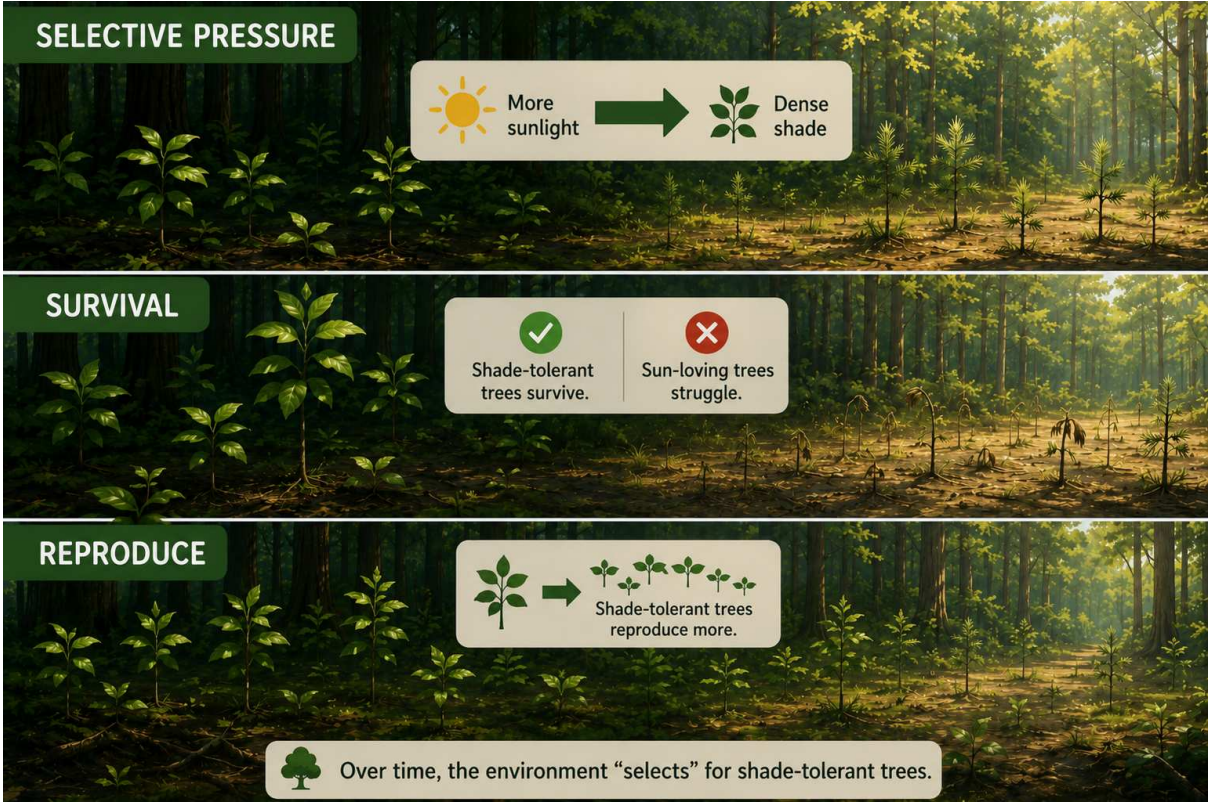
Mutations can create new alleles.

New alleles can add variation to a population.

Variation is important for natural selection.

→ Mutation creates new alleles and variation in a population.

Natural Selection: Advantage in an Environment



Natural Selection		⇒ Over time, the environment “selects” for shade-tolerant trees
Selective pressure	it affects an organism’s ability to survive and reproduce	environment change : More sunlight → dense shade
Survival	staying alive	shade-tolerant trees survive sun-loving trees struggle
Reproduce	create new offsprings	shade-tolerant trees reproduce more

Vocab	What it means
Selective advantage	a helpful trait
Natural selection	Nature favours traits that help survival / reproduction in an environment

Easy explanation

Natural selection happens when some traits help organisms survive.

A helpful trait is called a **selective advantage**.

Organisms with helpful traits are more likely to survive.

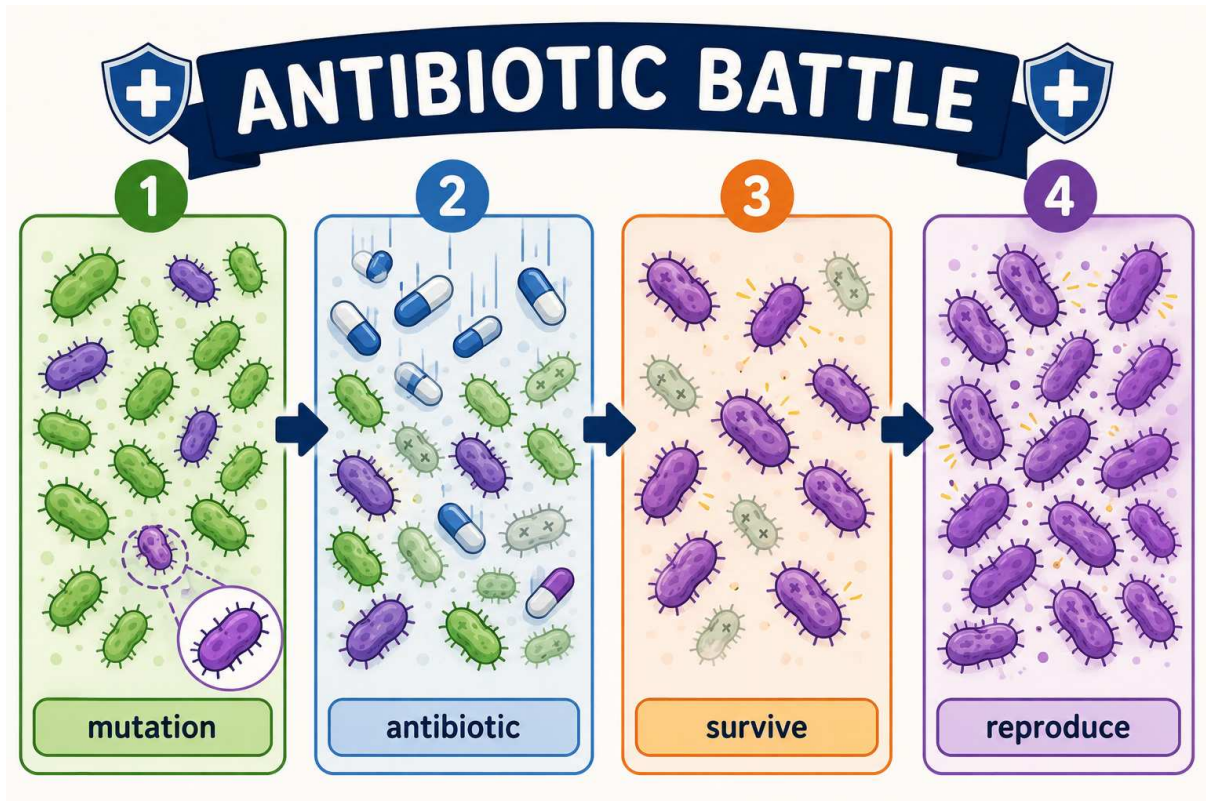
They are more likely to reproduce.

Their alleles can become more common over generations.

Important Line

Natural selection acts on **populations**, not just one individual.

Antibiotic Resistance Example



Mutation	Antibiotic	Survive	Reproduce
green bacteria become purple bacteria	- medicine (killing bacteria) is injected - medicine removes green bacteria	purple bacteria survived from the medicine	purple bacteria reproduce (make more offsprings)

Easy explanation

Some bacteria may have a mutation.

The mutation can make them resistant to an antibiotic (medicine).

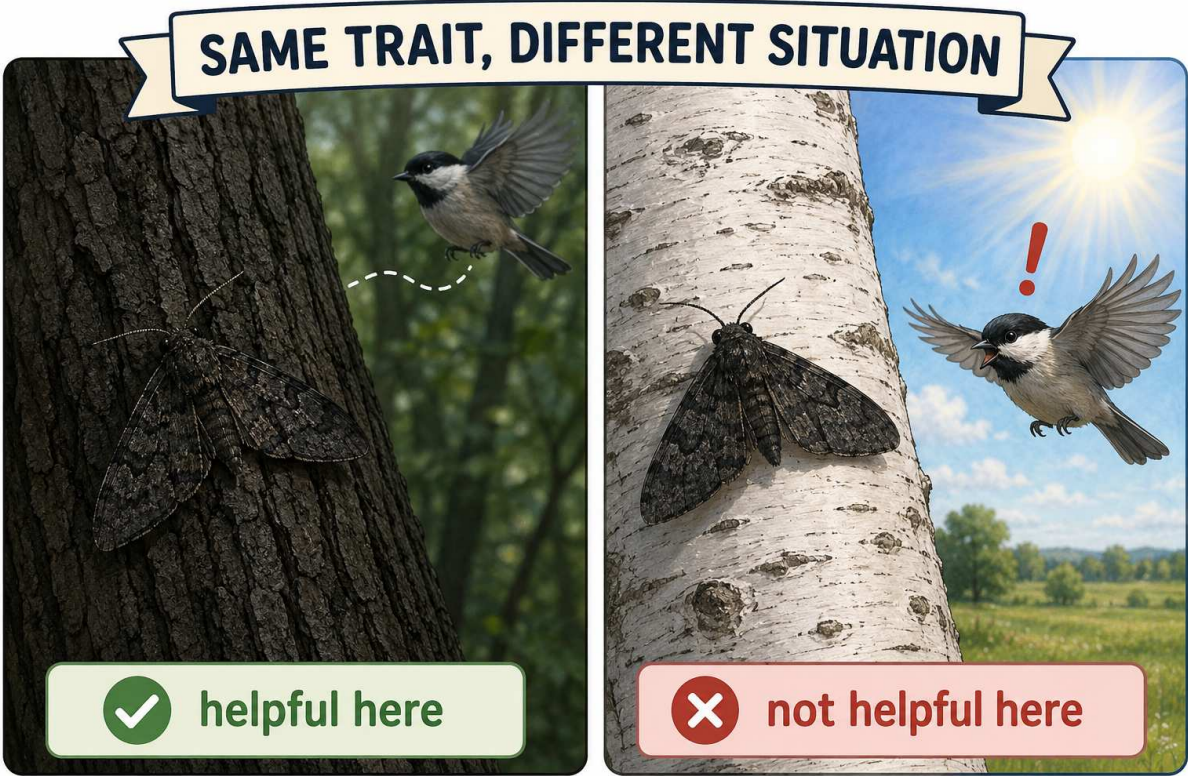
When antibiotics are used, non-resistant bacteria die.

Resistant bacteria survive.

They reproduce quickly.

Over time, the population changes.

Natural Selection Is Situational



Same trait - dark color	
Helpful here	Dark color is helpful to hide because the tree (environment) is also dark
Not helpful here	Dark color is not helpful here to hide because the tree (environment) is white The color makes it easier to be detected by birds (predator)

Easy Explanation

A trait can be helpful in one environment but not helpful in another.

Natural selection has no plan.

It depends on the environment.

A trait can be helpful in one place.

The same trait may not help in another place.

If the environment changes, the advantages can change too.

Adaptation



Vocab	What it means
Adaptation	structure/behaviour/process that helps survival and reproduction

Easy explanation

Adaptations can be:

body structures
behaviours
body processes

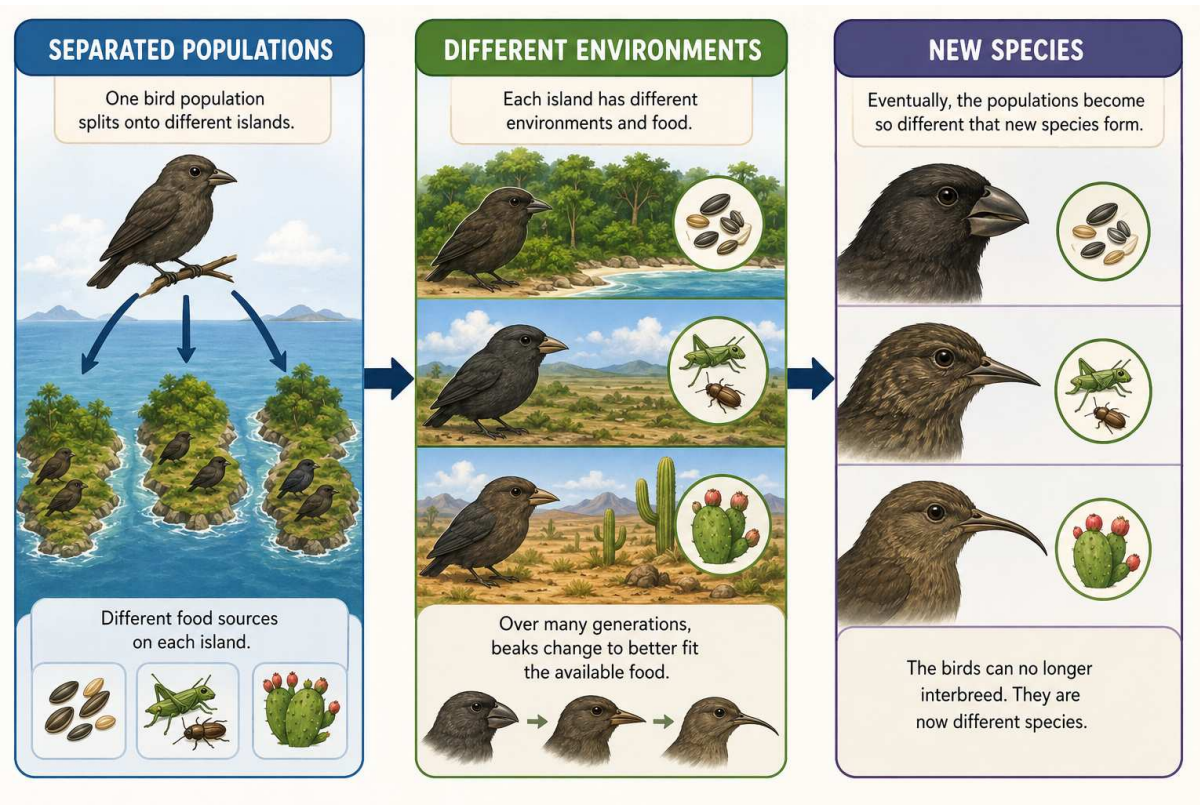
Examples:

Bird beaks help birds eat certain food.

Thick fur helps animals stay warm.

Cactus spines help protect the plant.

Speciation: New Species Can Form



Separated population	Different environment	New species
One bird population splits onto different islands	Each island has different environments and food	Eventually, the populations become so different that new species form.
Each island has different food sources	Over many generations, beaks change to better fit the available food.	The birds can no longer interbreed. They are now different species.

Vocab	What it means
Speciation	Because of different environments, populations can become very different and become new species over many generations

Easy explanation

A species is a group that can reproduce and have fertile offspring.

Sometimes populations become separated.

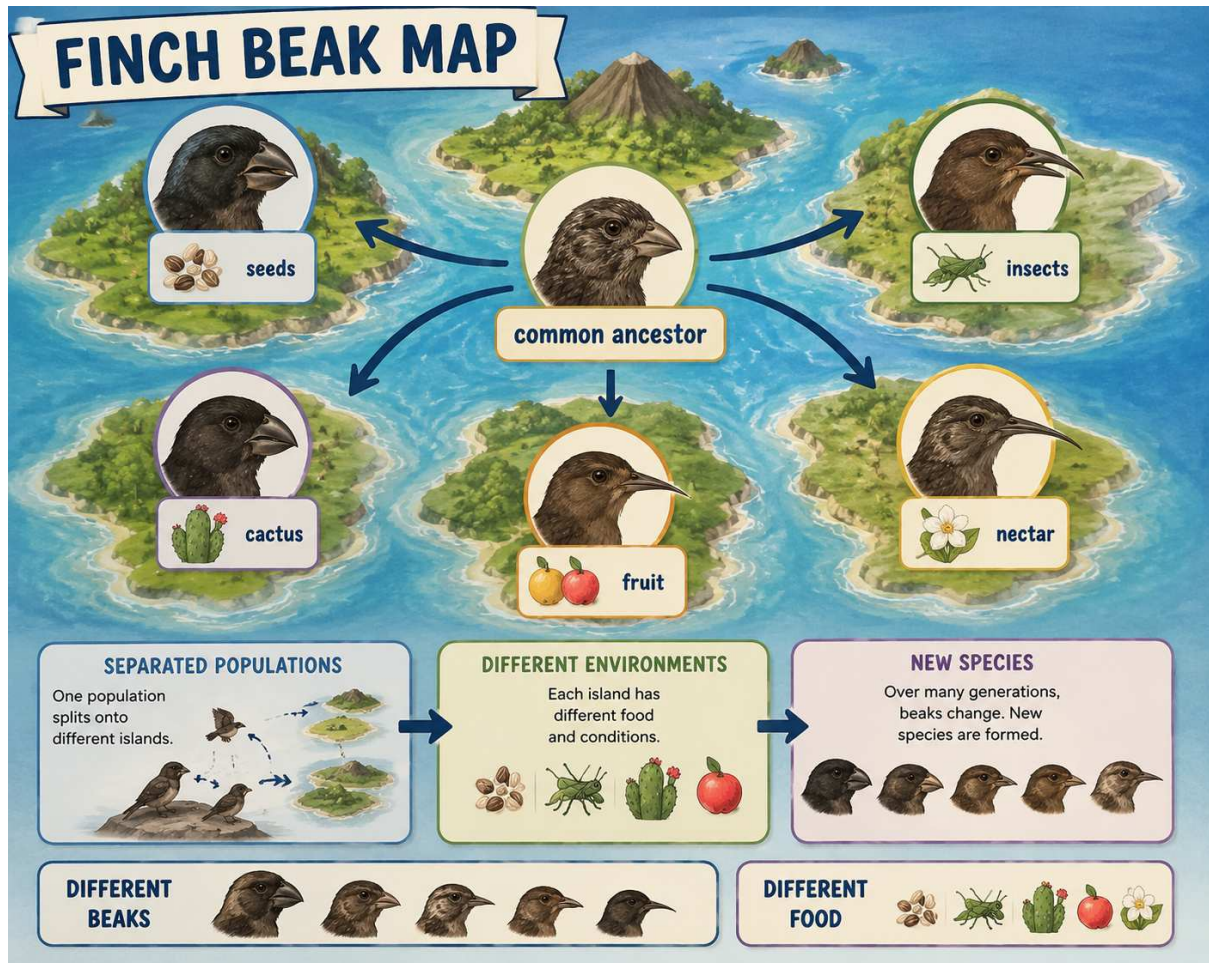
Different environments create different selective pressures.

Over many generations, populations can become very different.

They may become new species.

This is called **speciation** (When populations become separated and change over time, new species form)

Adaptive Radiation



Vocab	What it means
Adaptive Radiation	It happens when one ancestral species becomes many species

Easy explanation

This often happens when organisms move into different environments.

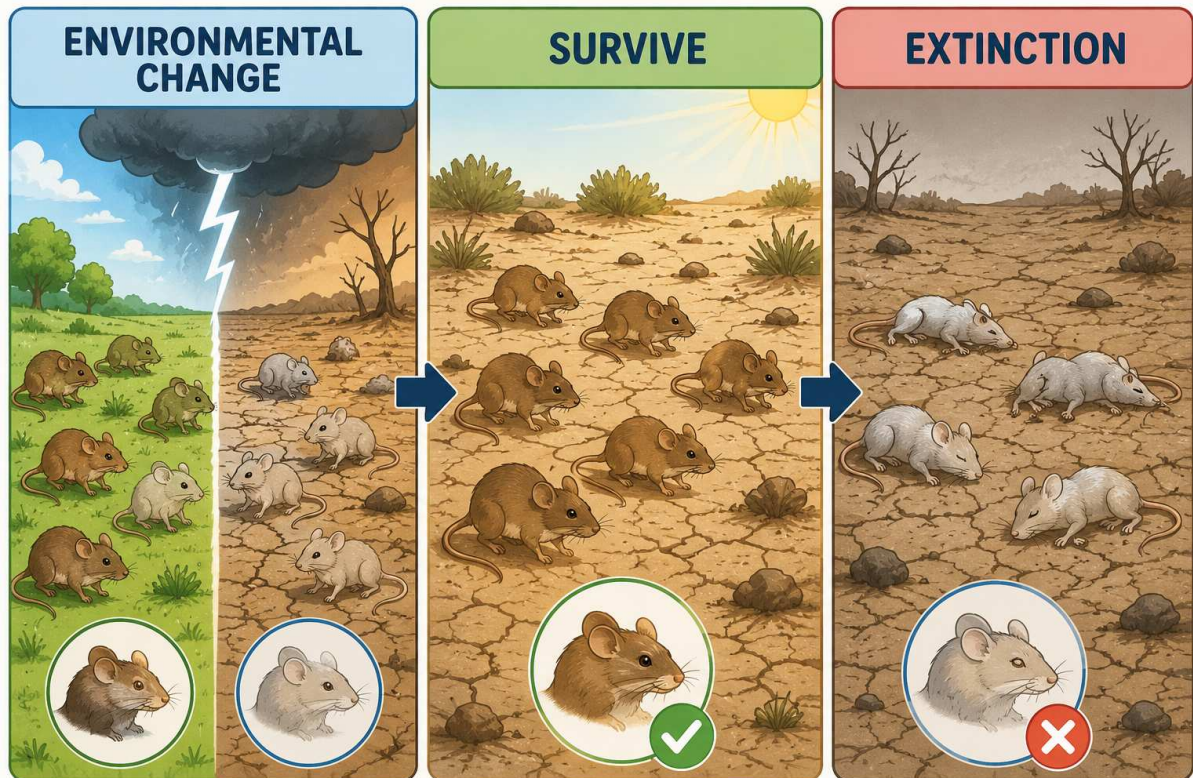
Different environments favour different traits.

Example:

Galapagos finches have different beak shapes.

Different beaks help them eat different foods.

Extinction and Selective Pressure



Vocab	What it means
Extinction	when a species disappears from Earth

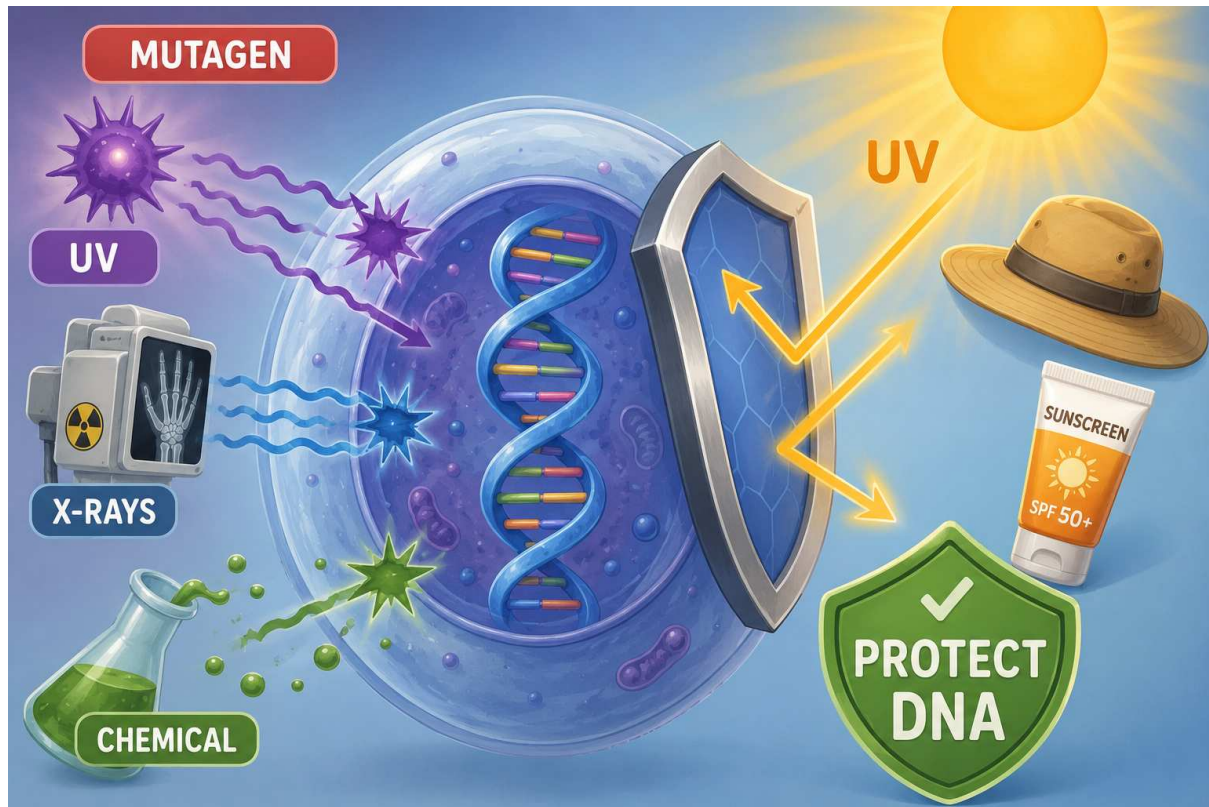
Easy explanation

Selective pressure can help new species form.

But it can also lead to extinction.

If a population cannot survive a changed environment (selective pressure), it may die out.

Environmental Factors Can Cause Mutations



Vocab	What it means
Mutagen	something that increases the chance of mutation
Carcinogen	something that can cause cancer

Easy explanation

Examples:

UV radiation

X-rays

some chemicals

Some mutagens are carcinogens.

A **carcinogen** is something that can cause cancer.

UV radiation can increase the risk of skin cancer.

Sunscreen and shade can reduce UV exposure.

Final Summary

Explanation

Genes are passed from parents to offspring.

Alleles affect traits.

Punnett squares predict possible offspring genotypes.

Mutations create new alleles.

New alleles create variation.

Natural selection acts on variation.

Over time, populations can change.

Sometimes new species form.

Sometimes species go extinct.