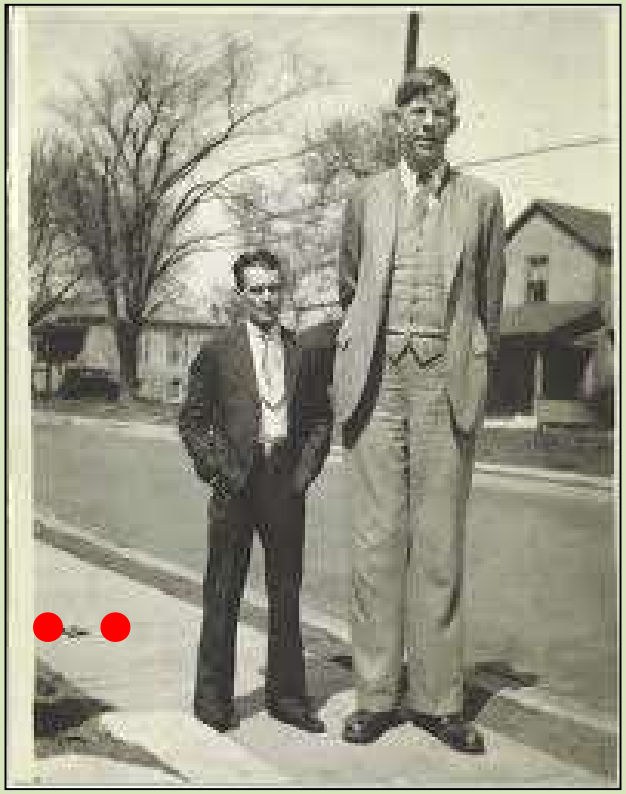
Genetics…



EQ: How are our genes passed to our offspring?

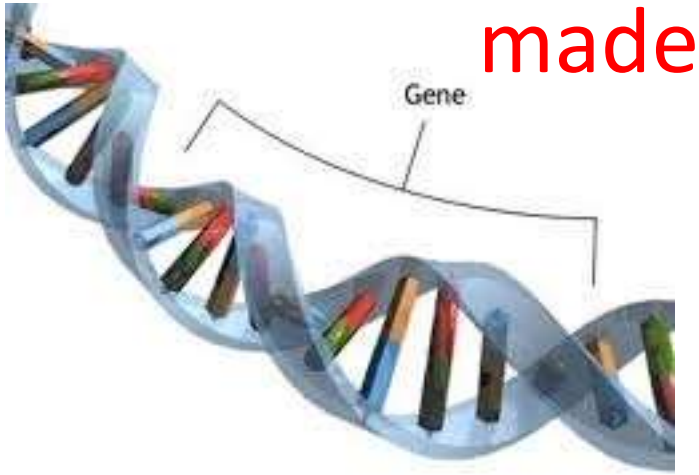
Genetics is the science that studies how genes are transmitted from one generation to the next.

Genes and Chromosomes

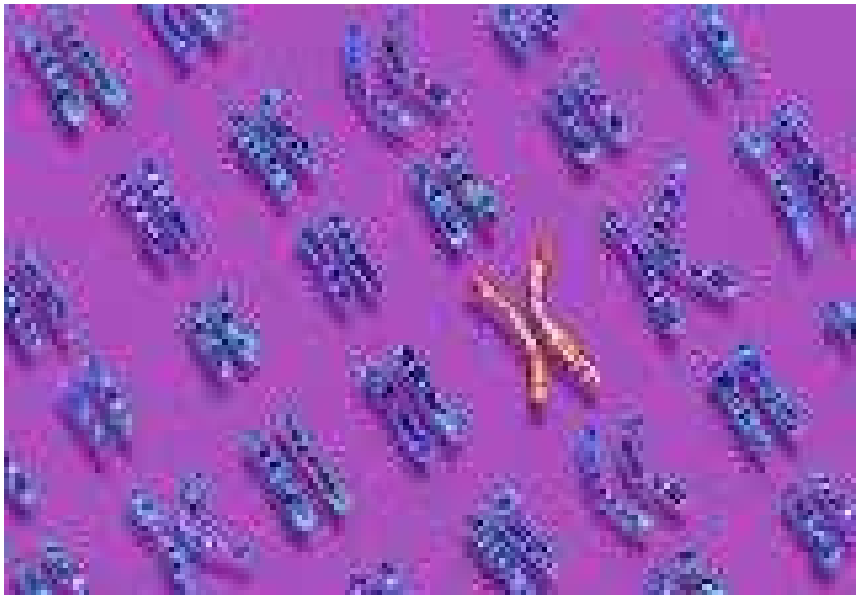
The chromosomes are contained in the nucleus of the cell.

Chromosomes are made of:

DNA



Gene: A segment of DNA that controls a hereditary trait.

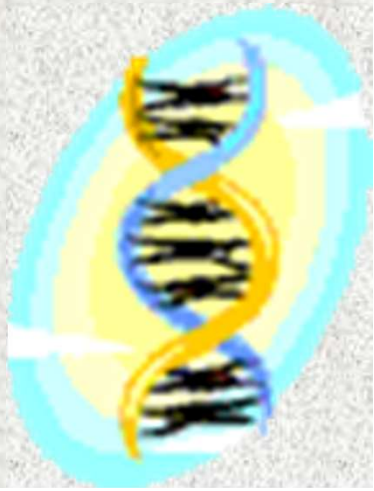


Chromosome: A long chain of genes.

Trait:

The characteristics that an organism has, such as hair color, eye color, tall or short, skin color.

Two alleles must be present in order for a trait to show up in the offspring. One must come from Mom and the other from Dad. When fertilization occurs, the new offspring will have 2 alleles for every trait.



Gregor Mendel

Gregor Mendel was an Austrian monk who was born in 1822.

He is known as the Father of Genetics.

He discovered three laws of genetics that would forever change biology. He conducted a series of experiments in a quiet monastery garden. Mendel spent 14 years growing and experimenting with the pea plants grown in his garden.

Mendel gave us the three basic laws of inheritance which are still used today:

The Law of Dominance and Recessiveness

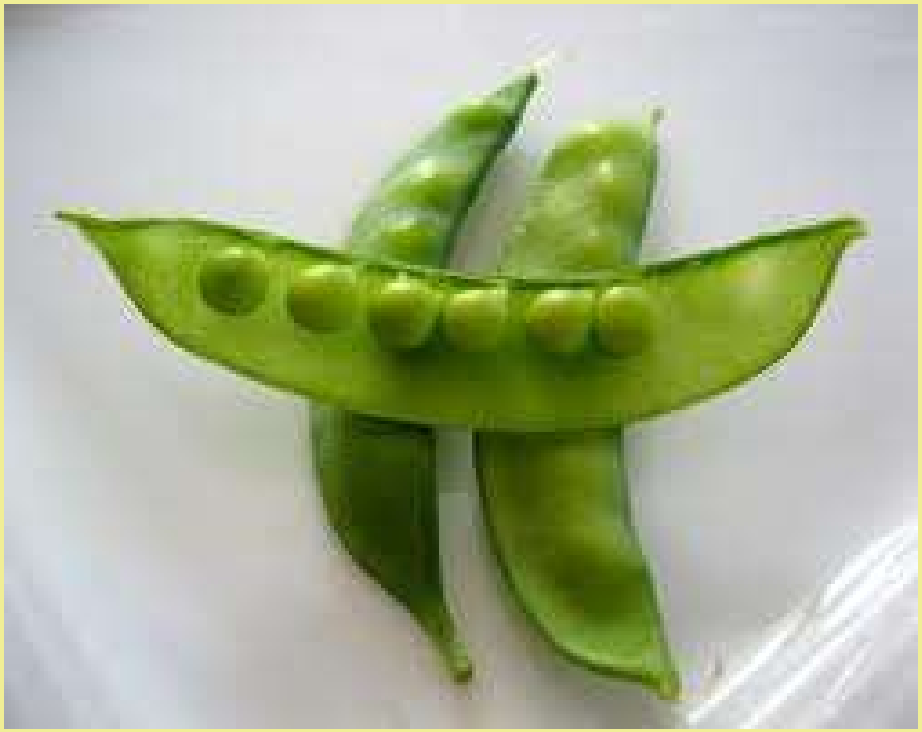
The Principle of Segregation

The Principle of Independent Assortment

Mendel's great contribution was to demonstrate that inherited characteristics are carried by genes.

Mendel chose for his experiments the garden pea.

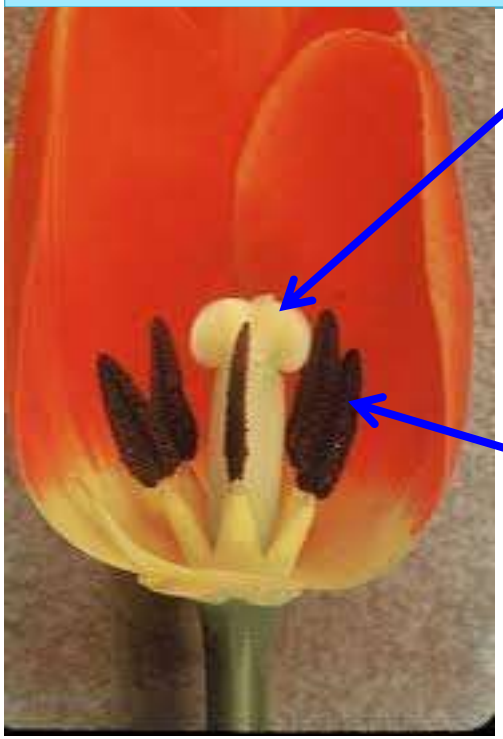
It was a good choice because:



1. They were readily available.
2. They were easy to grow.
3. They grew rapidly.

The sexual structures of the flower are completely enclosed within the petals so that there would be no accidental cross-pollination between plants.

Before we learn about Mendel's experiments, let's review the basics of sexual reproduction in flowering plants.



Flowers contain both male and female reproductive structures.

The female part of the flower:
The pistil produces egg cells.

The male part of the flower:
The stamen produces pollen which contains sperm cells.

When the pollen is delivered to the pistil, the sperm travels to the egg cell, and the result is fertilization.

Fertilization produces:
a tiny embryo, which is enclosed inside a seed.

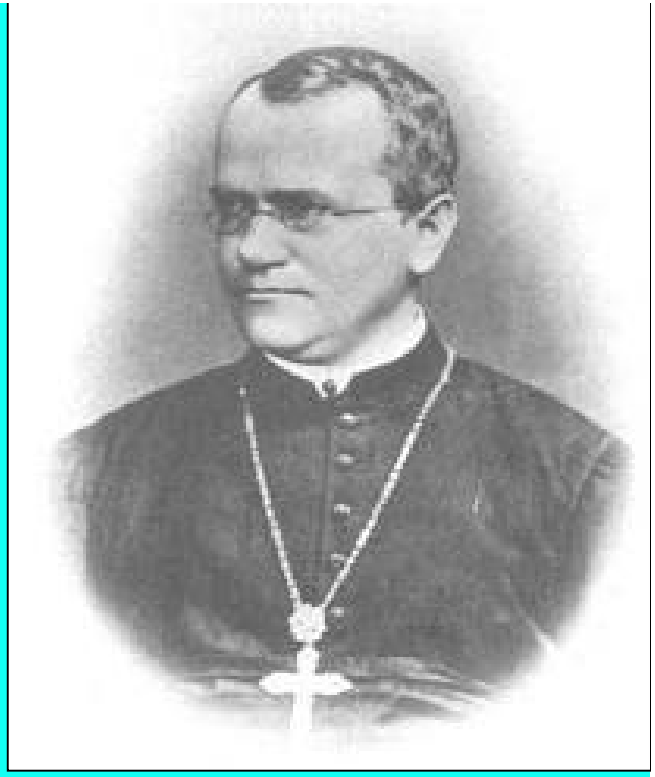
Mendel's Use of Pea Plants for Genetics Experiments

Pea flowers are normally _self-pollinating_. Since the male and female reproductive structures are relatively enclosed inside the flower, the sperm of the flower will fertilize the egg of the same flower.

The resulting embryos will have the same _characteristics_ as the parent plant. Even though sexual reproduction has occurred, there is just one _parent_.

Mendel knew that these pea plants were “true breeding”. This means that if they are allowed to self-pollinate, they would produce: offspring identical to themselves.

For example: If allowed to self-pollinate, tall plants would always produce tall plants. Plants with yellow seeds would always produce offspring with yellow seeds.



These true breeding plants were the cornerstone of Mendel’s experiments.

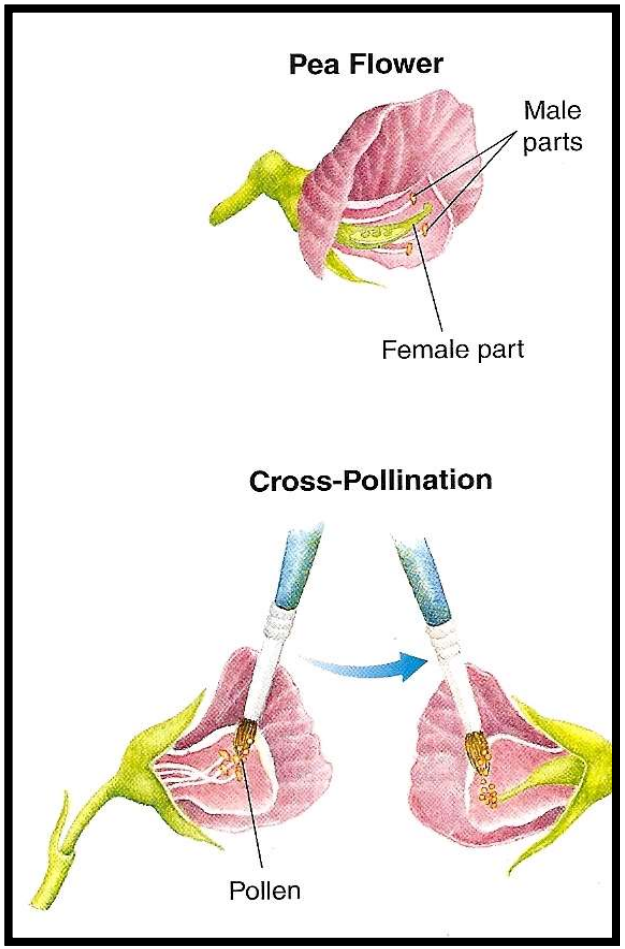
Mendel's Work

Mendel wanted to produce seeds by joining the egg and sperm from _two different plants_.
To do this, he had to first prevent the possibility of _self-pollination_.

Mendel cut away the stamens, the male reproductive parts of the flower, and then dusted the remaining female structure with pollen from a different plant.

This is known as _cross-pollination_ and produces offspring from two _different_ parents.

Now Mendel could easily crossbreed plants and experiment with different characteristics.

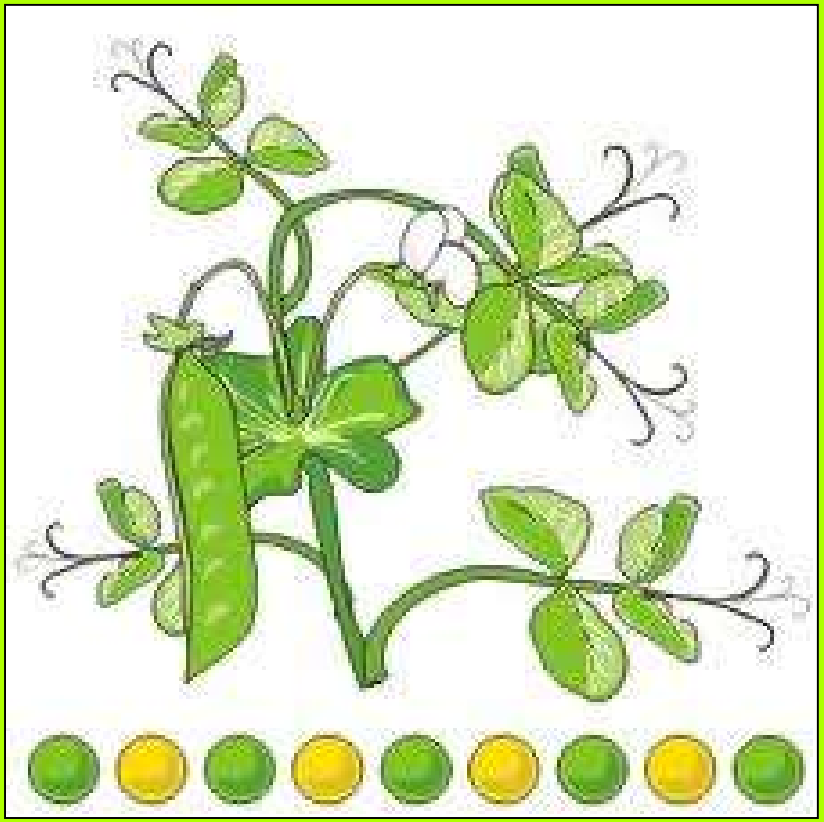


Which thumb do you put on top?

Before we proceed, you must be familiar with the following terms:

1. P generation: Parental generation
2. F_1 generation: First generation of offspring
3. F_2 generation: Second generation of offspring
4. Hybrids: The offspring of parents with different traits.

MENDEL'S EXPERIMENTS



Mendel crossed true-breeding tall plants with true-breeding dwarf plants.

Tall x dwarf → all tall offspring

1. The F_1 hybrids were all tall.
2. All of the offspring had the appearance of only one of the parents.
3. The trait of the other parent seemed to have disappeared. Mendel thought that the dwarf trait had been lost.

Mendel's Two Conclusions

Biological inheritance is determined by "factors" that are passed from one generation to the next.

Today, we know these factors to be genes.

Each of the traits that Mendel observed in the pea plants was controlled by one gene that occurred in:

two contrasting forms.

For example: The gene for the height of pea plants occurs in a tall form and in a dwarf form. The different forms of a gene are called alleles.

Mendel realized that some alleles are dominant over other alleles.

Mendel's Seven F_1 Crosses on Pea Plants

	Seed Shape	Seed Color	Seed Coat Color	Pod Shape	Pod Color	Flower Position	Plant Height
P	Round X Wrinkled	Yellow X Green	Gray X White	Smooth X Constricted	Green X Yellow	Axial X Terminal	Tall X Short
F_1	Round	Yellow	Gray	Smooth	Green	Axial	Tall

Principal of Dominance and Recessiveness:

Some alleles are dominant and others are recessive. A dominant allele can cover up or mask a recessive allele.

Dominant allele: If the dominant allele is present in an offspring: the dominant trait will show up in the offspring.

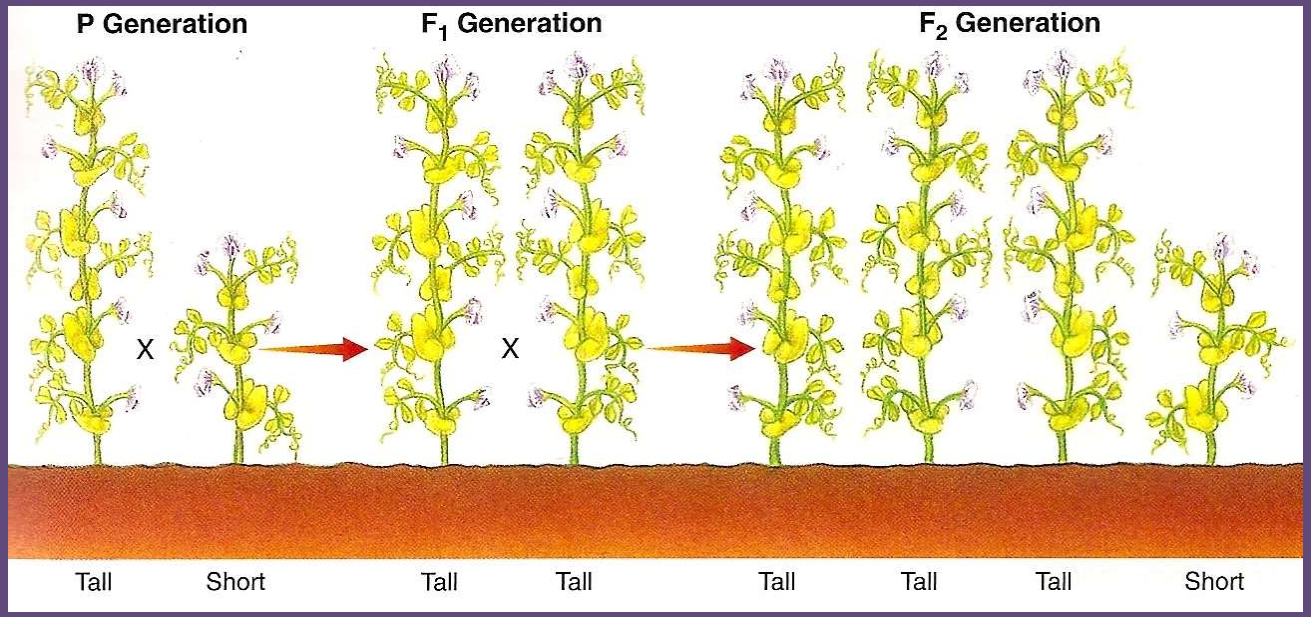
Recessive allele: This trait will show up in the offspring only if: the dominant allele is not present.

Mendel had another question:

Had the dwarf trait (recessive allele) disappeared, or was it still present in the F_1 offspring?

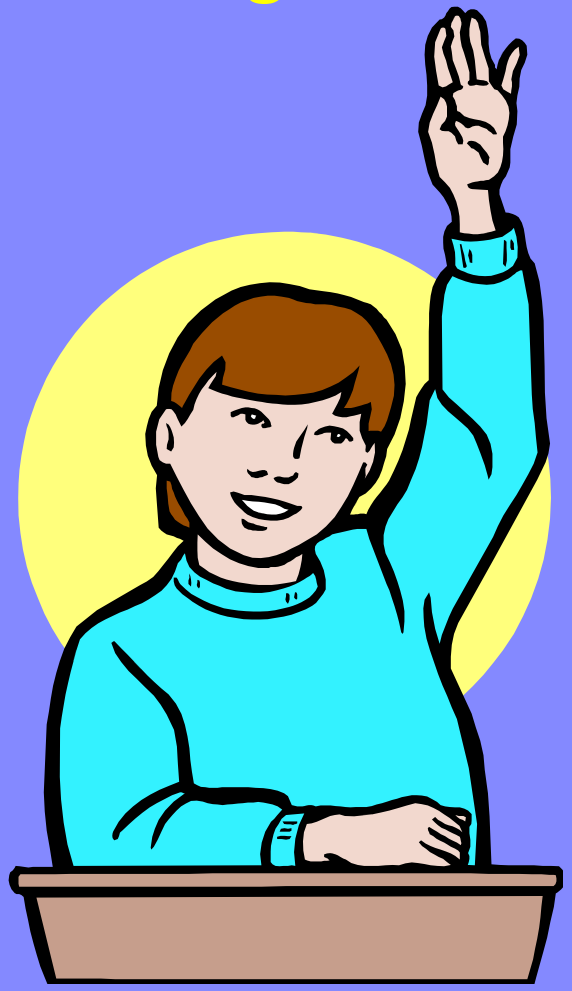
Mendel allowed the hybrid tall offspring from the first generation to self-pollinate.

F_1 Tall x F_1 Tall → offspring: ¾ tall and ¼ dwarf



1. He found that ¾ of the offspring were tall and ¼ of the offspring were dwarf.
2. Evidently the F_1 "tall" offspring must have been carrying the dwarf trait, but it had been hidden.
3. The dwarf trait had been passed down to the offspring and it reappeared in the F_2 generation.

Why did the recessive allele seem to disappear in the F_1 generation and then reappear in the F_2 generation?

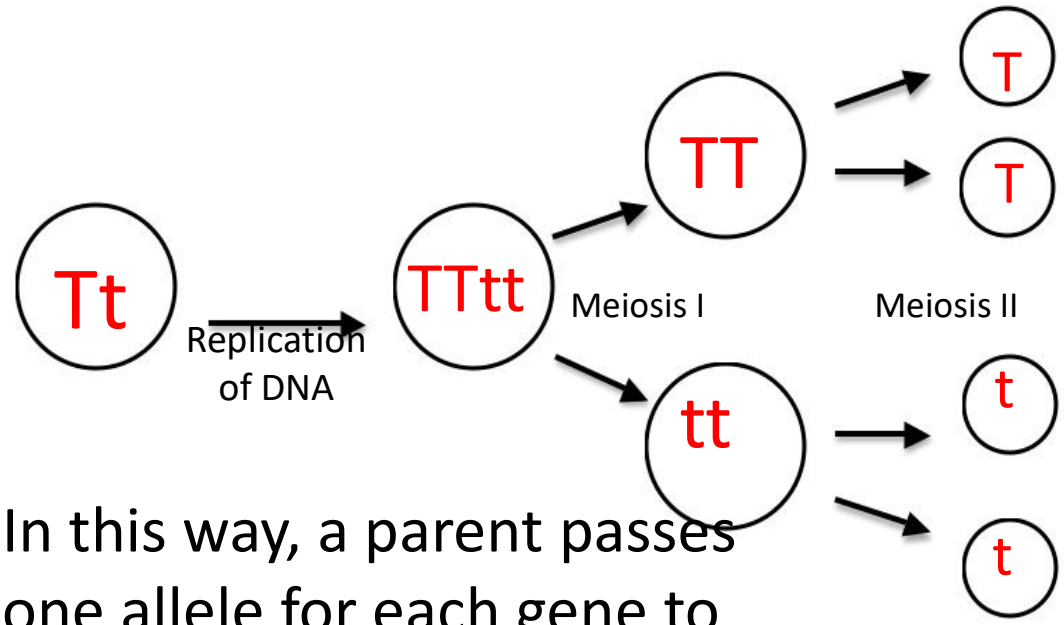


Mendel realized that organisms have two alleles for every trait. These two alleles are inherited, one from each parent. If the offspring receives a dominant allele from one parent, that dominant trait will appear in the offspring. Recessive traits show up in the offspring only if: the offspring receives recessive alleles from each parent.

If a parent has two alleles for a trait, how does the parent pass only one allele to the offspring?

Today, we know that the answer to this lies in the type of cell division known as meiosis, the formation of gametes.

Gametes are: sex cells or egg and sperm cells.



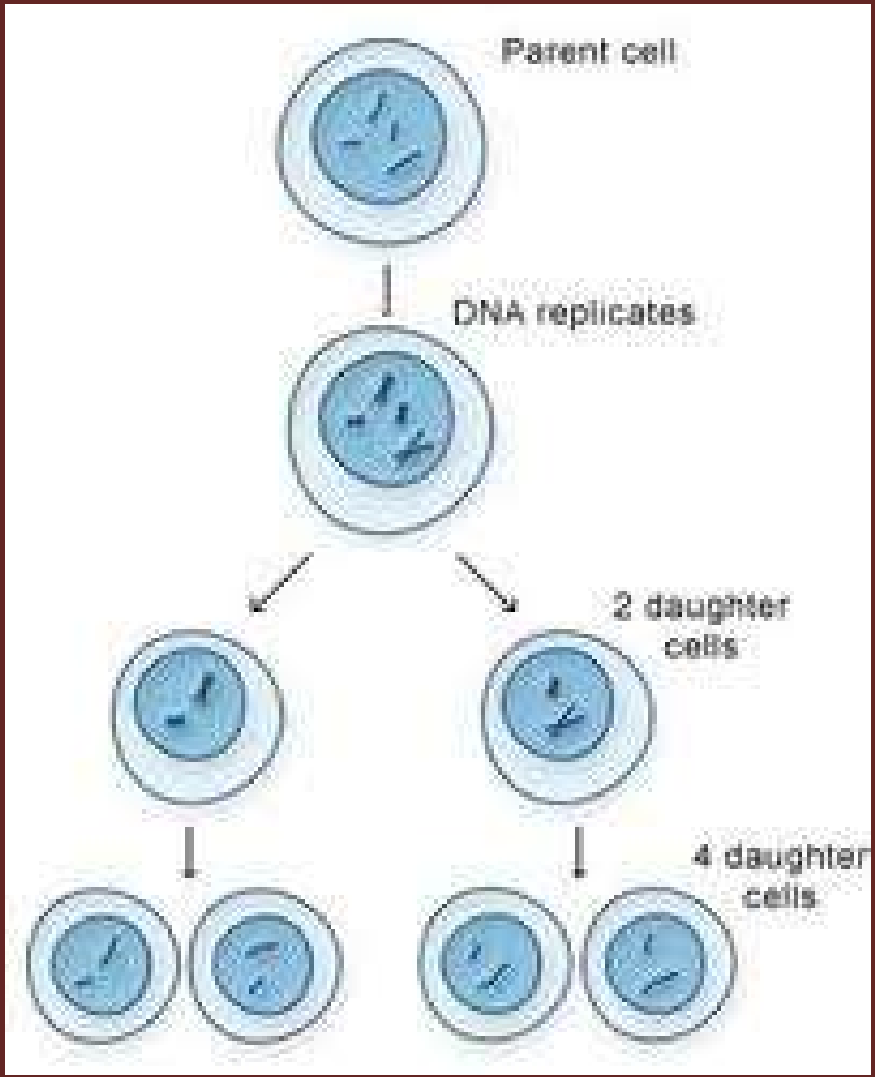
In this way, a parent passes one allele for each gene to their offspring.

The capital letter, T, represents a dominant allele.

The lower case letter, t, represents a recessive allele.

During meiosis, the DNA is replicated and then separated into 4 gametes.

Mendel's Principle of Segregation



Mendel's Principle of Segregation says that every individual carries 2 alleles for each trait. These two alleles separate or segregate during the formation of the egg and sperm cells.

HOMOZYGOUS OR HETEROZYGOUS?

An offspring will inherit two alleles for a trait, one allele from each parent. The combination of alleles received by the offspring may be either homozygous or heterozygous.

Homozygous means that…

…the two alleles are the same: TT or tt

Heterozygous means that…

…the two alleles are different: Tt

Left side Activity

Define the following terms and draw a picture or give an example of each.

1. Genetics
2. Chromosome
3. Trait
4. Gene
5. Dominant Allele
6. Recessive Allele
7. Gametes
8. Homozygous
9. Hetrozygous