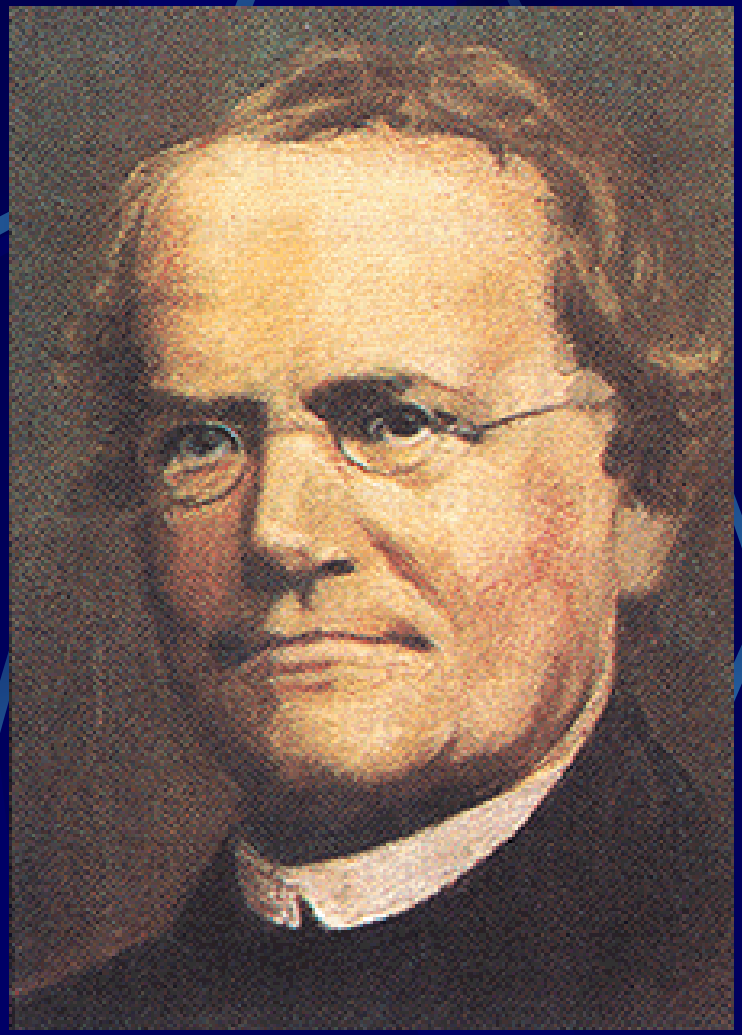
Introduction to Genetics

Gregor Mendel and his wacky peas

What is genetics?

The scientific study of heredity

Gregor Mendel



- Born in 1822 in Czechoslovakia.
- Became a monk at a monastery in 1843.
- Taught biology and had interests in statistics.
- Also studied at the University of Vienna

Mendel continued

- Most famous for his work with pea plants
- Between 1856 and 1863 he grew and tested over 28,000 pea plants
- (That's what he is contemplating so seriously in the picture)

Why Peas?

Easy to grow.

Easily identifiable traits

- Trait – a specific characteristic

Can work with large numbers of samples

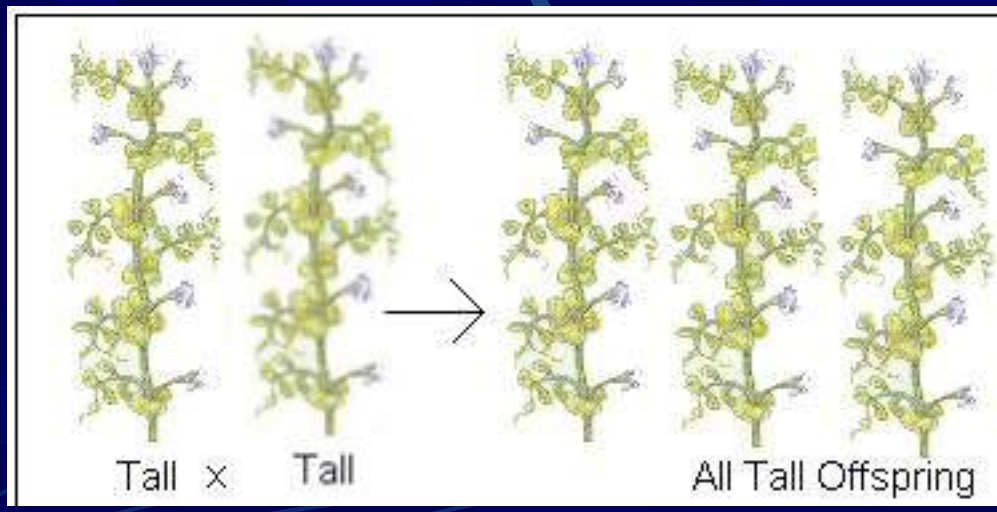
Character	Dominant Trait	×	Recessive Trait
Flower color	Purple 	×	White 
Flower position	Axial 	×	Terminal 
Seed color	Yellow 	×	Green 
Seed shape	Round 	×	Wrinkled 
Pod shape	Inflated 	×	Constricted 
Pod color	Green 	×	Yellow 
Stem length	Tall 	×	Dwarf 

Mendel's experiments

The first thing Mendel did was create a "pure" plant or true-breeding plant.

- True breeding – If the parent repeatedly only produce offspring with the same trait

•For example: A plant true-breeding for purple flowers will always produce offspring with purple flowers.



Mendel's experiments

What happens if you cross two plants which are true-breeding for contrasting traits???

purple flowers x white flowers

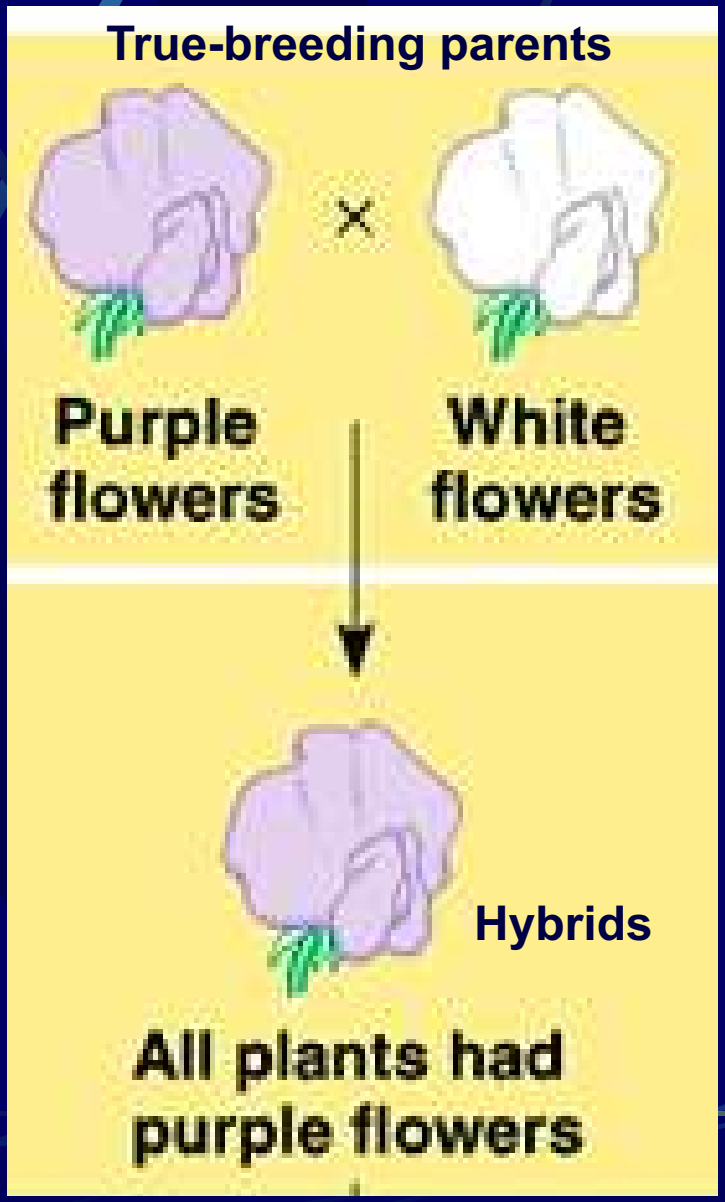
wrinkled seeds x smooth seeds

tall plants x short plants

etc, etc, etc,

Mendel's experiments

- He always found the same pattern
- He discovered that even though one of the parent plants had white flowers, ALL of the offspring had purple flowers!



Mendel's experiments

Mendel repeated this experiment with other traits, in every case, one trait "won out"

- For example: Purple flower color "won out" over white flower color. Smooth seed texture "won out" over wrinkled seed texture.

Mendel's experiments

Mendel called the trait that "won out" in the offspring **dominant** (purple flowers) .

He called the trait that dissappeared in the offspring **recessive** (white flowers) .

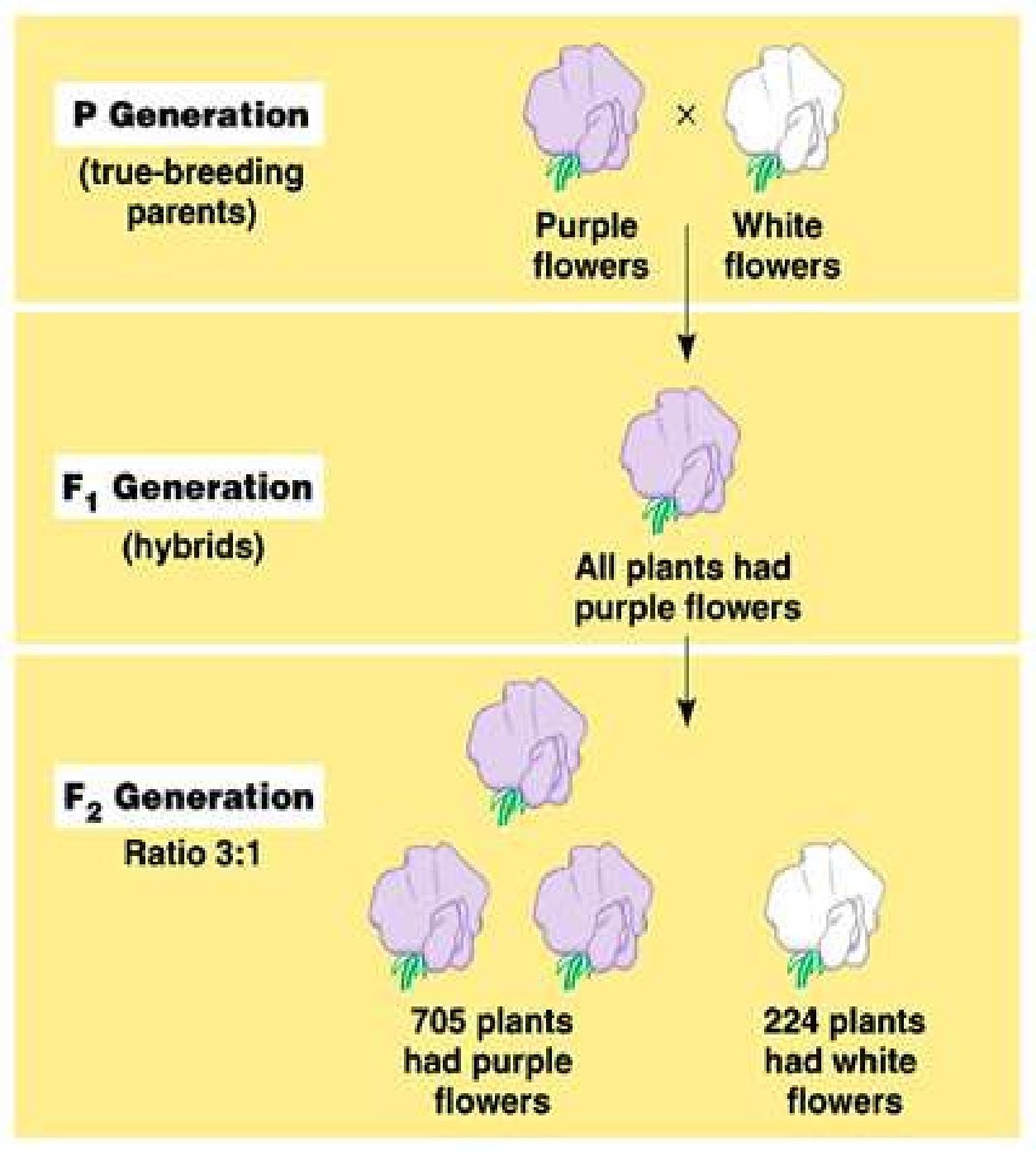
Mendel's experiments

What would happen when Mendel let the offspring self-pollinate? Was the next generation true-breeding for the dominant trait?

- Would Mendel continue to see only purple flowers?

No!

The white flowers reappeared (about ¼)



From his experiments, Mendel concluded two things

1. Inheritance is determined by *factors* passed on from one generation to another.
   - Today these "factors" are called genes, but Mendel knew nothing about chromosomes, genes or DNA because there terms hadn't been identified yet
   - Allele – difference forms of a gene

From his experiments, Mendel concluded two things

2. Some alleles are dominant while other are recessive.

- An organism with a dominant allele for a trait will always express that allele.
- An organism with a recessive allele for a trait will express that form only when the dominant allele is not present.

Which led him to create to "laws" of inheritance

1. **The Law of Segregation**: Two factors (alleles) control each specific characteristic (gene). These factors (alleles) are separated during the formation of gametes (sex cells).

Which led him to create to "laws" of inheritance

2. **The Law of Independent Assortment**: Factors (alleles) for different characteristics (genes) are distributed to gametes (sex cells) independently. This means that the allele for seed texture isn't dependent on the allele for plant height, etc.

Probability

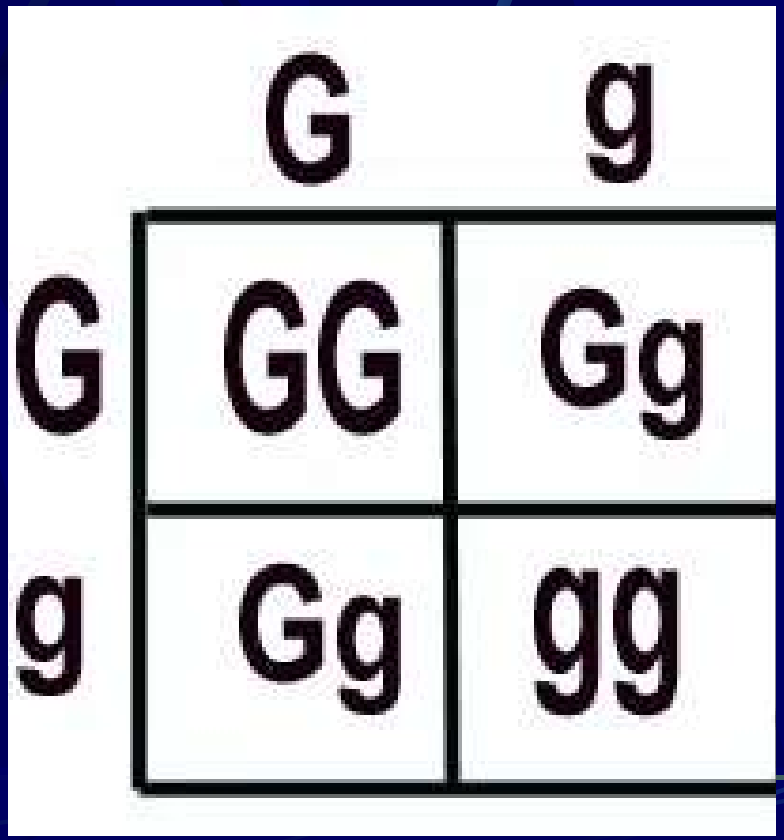
The likelihood of a particular event occurring.

Can be expressed as a fraction, percent or ratio.

The more trials performed, the closer the actual results to the expected outcomes.

Punnett Square

A diagram used to show the probability or chances of a certain trait being passed from one generation to another.



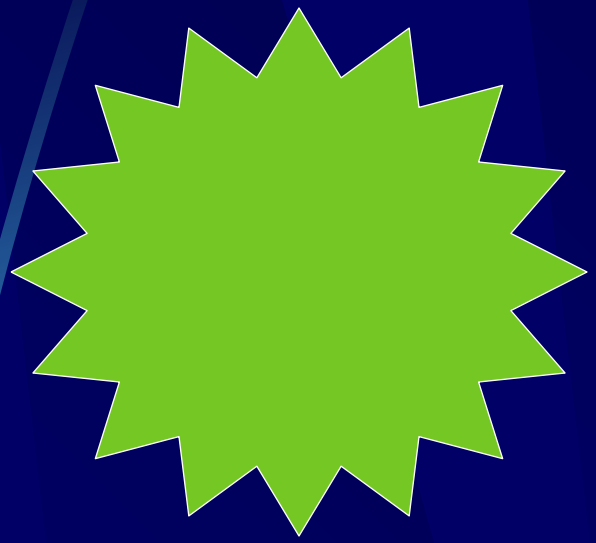
Using a Punnett square

1. Gametes are placed above and to the left of the square
2. Offspring are placed in the square.
3. Capital letters represent dominant alleles. (Y)
4. Lower case letters represent recessive alleles. (y)

Punnett square example

In a cross between PP x Pp. What percent of the offspring would you expect to be purple?

P = purple, p = white



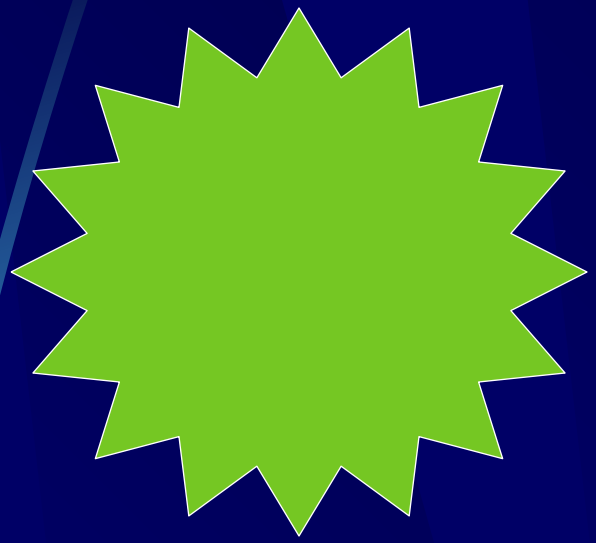
One parent goes here

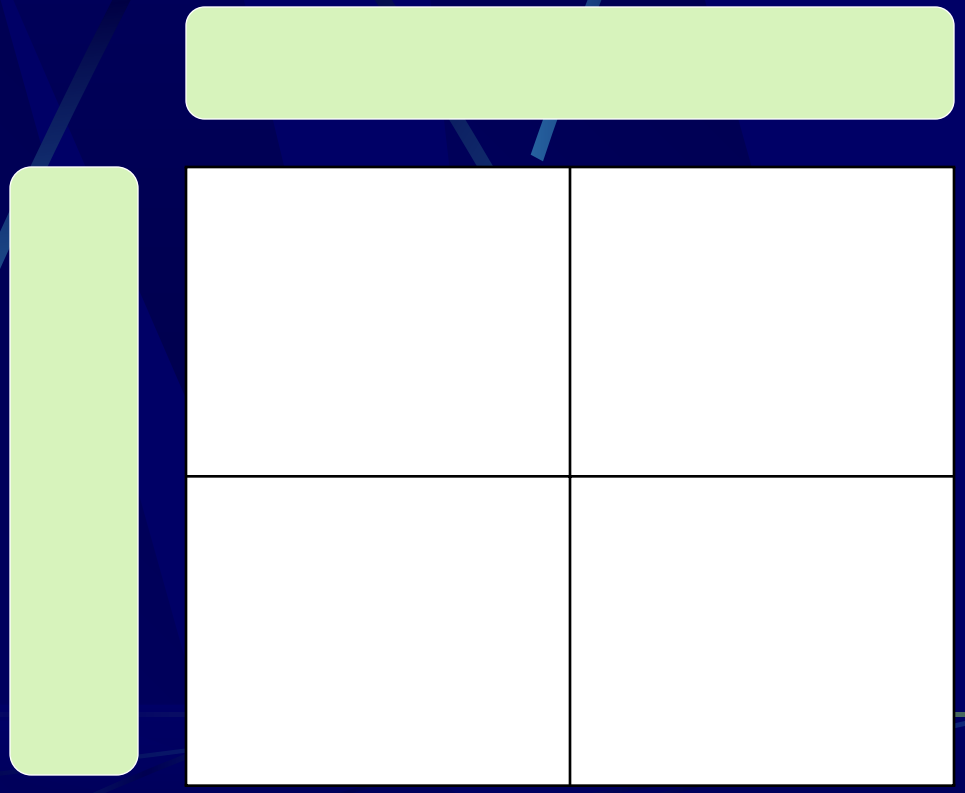
One parent goes here

Let's do another one...

In a cross between Pp x Pp. What percent of the offspring would you expect to be white?

P = purple, p = white





Vocabulary

Dominant – allele, which if present, will ALWAYS be expressed

- Represented by a capital letter, usually the first letter of the dominant trait

Recessive – allele, which will only be expressed in the absence of a dominant allele

- Represented by a lowercase letter, the same letter as the dominant trait, just lowercase

For example: Tall is dominant over short, T = tall, t = short

Vocabulary

Homozygous = when an organism has two identical alleles.

- YY or yy

Heterozygous = when an organism has different alleles.

- Yy

Vocabulary

Genotype

- The genetic makeup
- Symbolized with letters
- For example: Tt or TT

Phenotype

- Physical appearance of an organism
- Description of the trait
- For example: Tall, short, purple, white

Some exceptions to Mendel's principles:

- Some alleles are neither dominant nor recessive.
- Many traits are controlled by more than one gene (polygenic traits)

Incomplete dominance

A situation in which neither allele is dominant.

When both alleles are present a “new” phenotype appears that is a blend of each allele.

Alleles will be represented by capital letters only.

Japanese four-o-clock flowers

Red flower plant genotype = RR

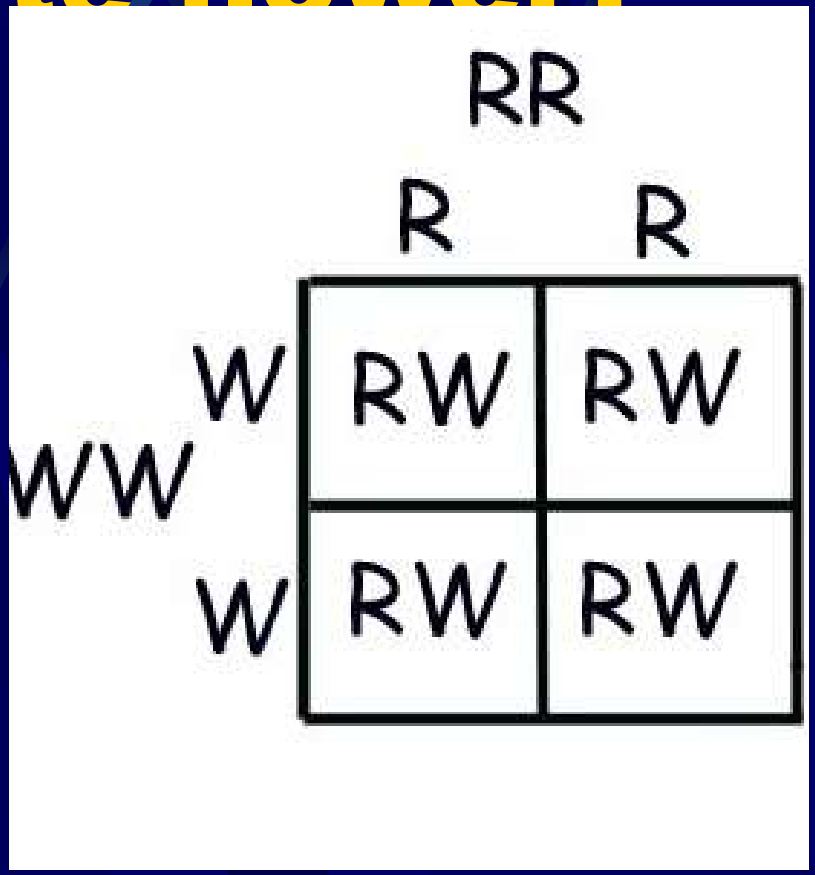
White flower plant genotype = WW

Pink flower plant genotype = RW

What happens when a red flower is crossed with a white flower?

According to Mendel either some white and some red or all offspring either red or white.

All are pink



Codominance

When two alleles both appear in the phenotype.

Usually signified using superscripts.

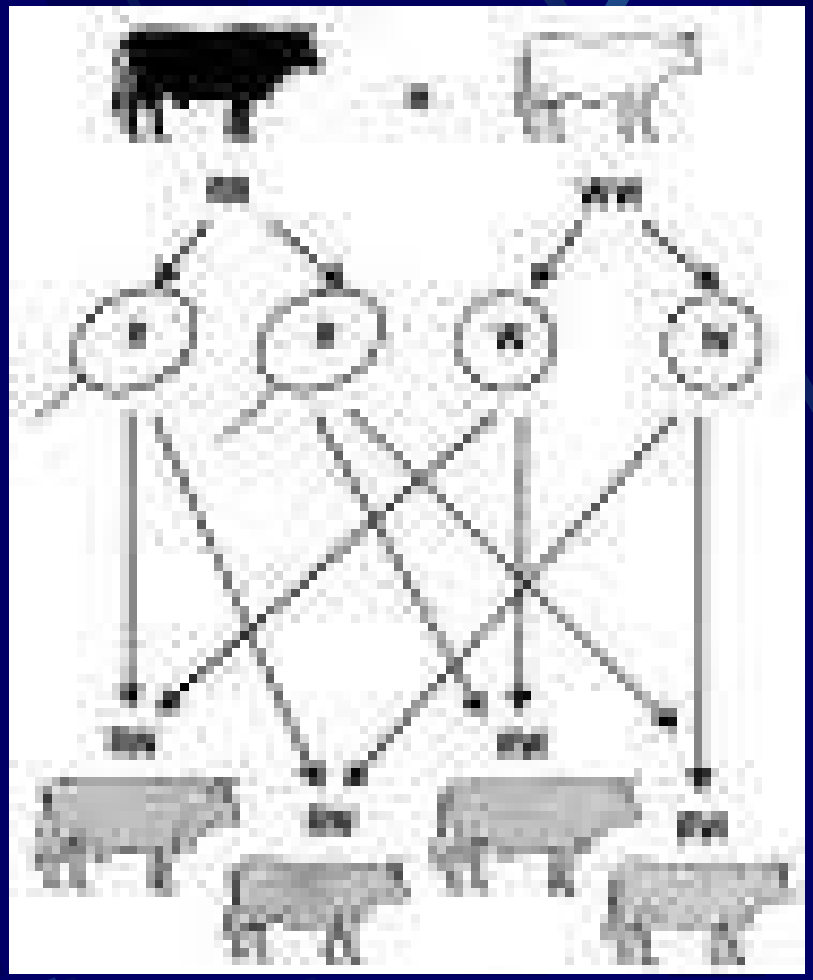
example: color of hair coat in cattle.

$c^r c^r$ = red hairs

$c^w c^w$ = white hairs

$c^r c^w$ = roan coat (mixture of both colors)

Roan cattle inheritance



Multiple allele inheritance

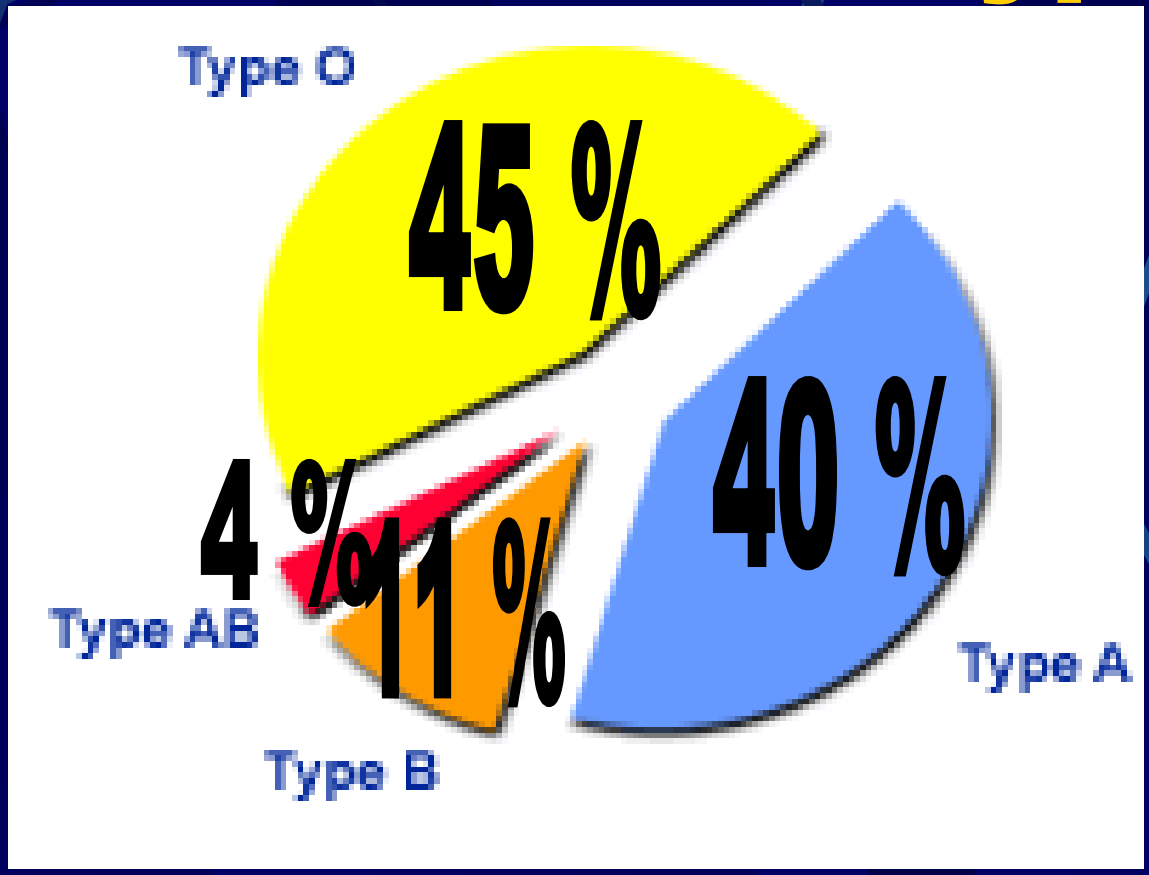
When two or more alleles contribute to the phenotype.

Human blood types: A,B,O and AB

A and B are codominant to each other.

Both A and B are dominant over O.

How common are the different blood types?



Polygenic traits

Traits controlled by two or more genes.

Examples:

- Human height
  eye and skin
  color