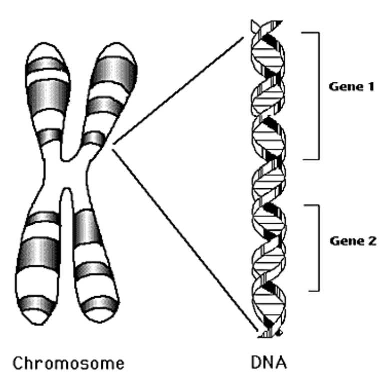
Standard: Students will analyze how biological traits are passed on to successive generations.

Element: Using Mendel's Laws, explain the role of meiosis in reproductive variability.

EQ: What are Mendel's Laws and how did he come up with them?

I) Describing Genetics

A) **Gene**: segment of DNA that codes for a particular characteristic (eye color, hair color, height)



Genes

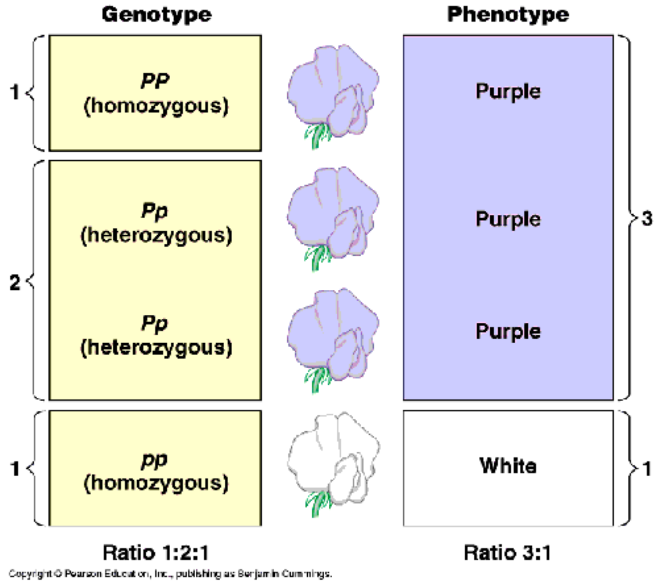
B) **Allele**: version of a gene that codes for one specific trait (one allele codes for brown eyes, a different allele codes for blue eyes)

1) Alleles are represented by a single-letter abbreviation
2) The letter is capitalized for *dominant alleles* (dominant alleles are always expressed whenever they are present)
3) The letter is lowercase for *recessive alleles* (recessive alleles are only expressed if there are no dominant alleles present)

C) **Genotype**: the combination of alleles present in an individual, usually written as two single-letter abbreviations (one for each allele) ↗ true breeding

1) **Homozygous**: when an individual has two copies of the same allele (TT or tt)
2) **Heterozygous**: when an individual has two different versions of an allele for the same characteristic (Tt); also called a **hybrid**

D) **Phenotype**: the physical appearance of an individual; this is determined by the individual's genotype

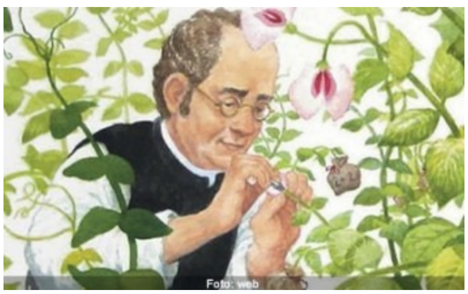


II) Gregor Mendel

A) Austrian monk known as the "father of genetics"

B) Conducted extensive studies of the genetics of pea plants

C) Determined basic patterns of inheritance without ever knowing about DNA

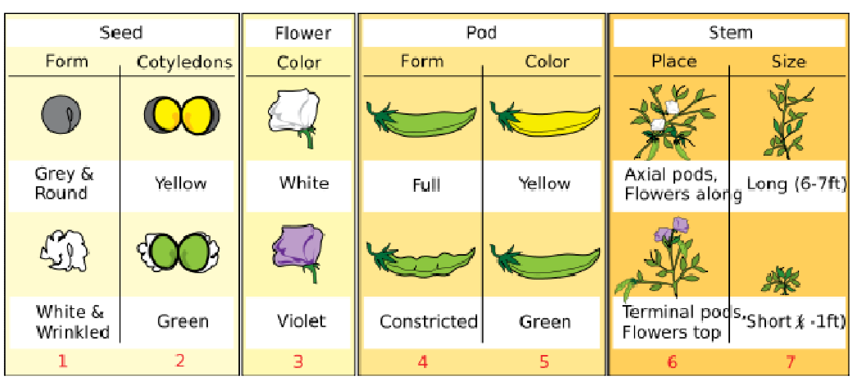


III) Mendel's Experiments

A) Pea Plants: the test subject

1) Pea plants are able to self-pollinate, allowing Mendel to create pure-bred parent generations.

2) They have a variety of traits that are easily distinguishable from one another, making results easy to determine (purple/white flowers, round/wrinkled seeds, green/yellow seeds, axial/terminal flowers, etc.)

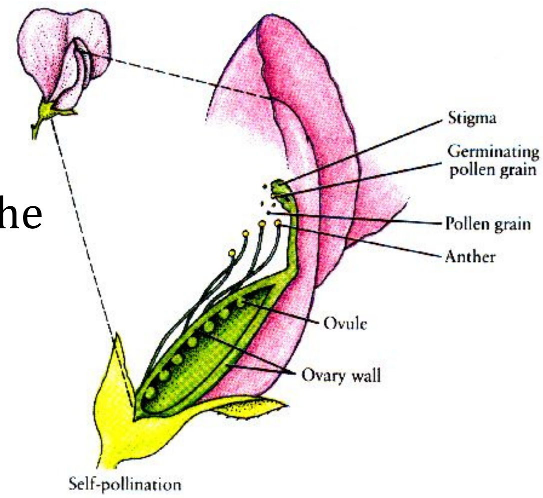


3) Plants were easy to grow and produced reliable, reproducible results.

B) Creating the **P generation**

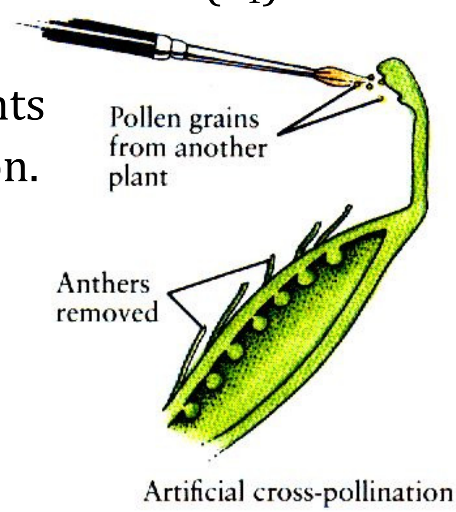
1) The "Parent" (or P) generation consisted of true-breeding pea plants. Mendel very carefully self-pollinated pea plants for several generations in order to ensure they were "pure" for whichever trait he was interested in.

2) For example, Mendel self-pollinated plants with purple flowers so that he could be sure that all offspring from those plants would be homozygous for the purple allele.

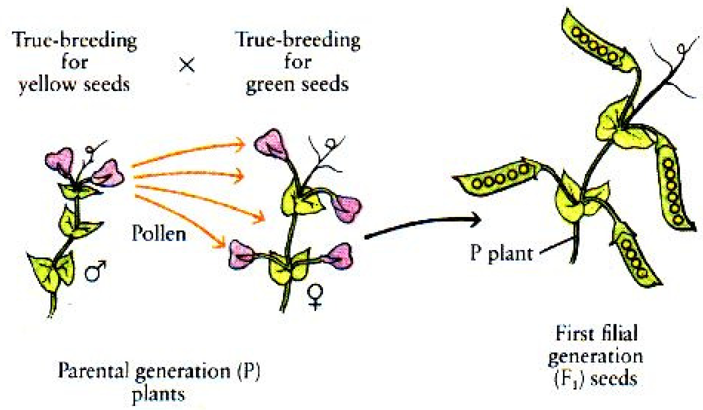


C) Creating the $\mathbf{F_1}$ **generation**

1) The first "Filial" generation (F_1) was the result of crossing two different plants of the P generation.

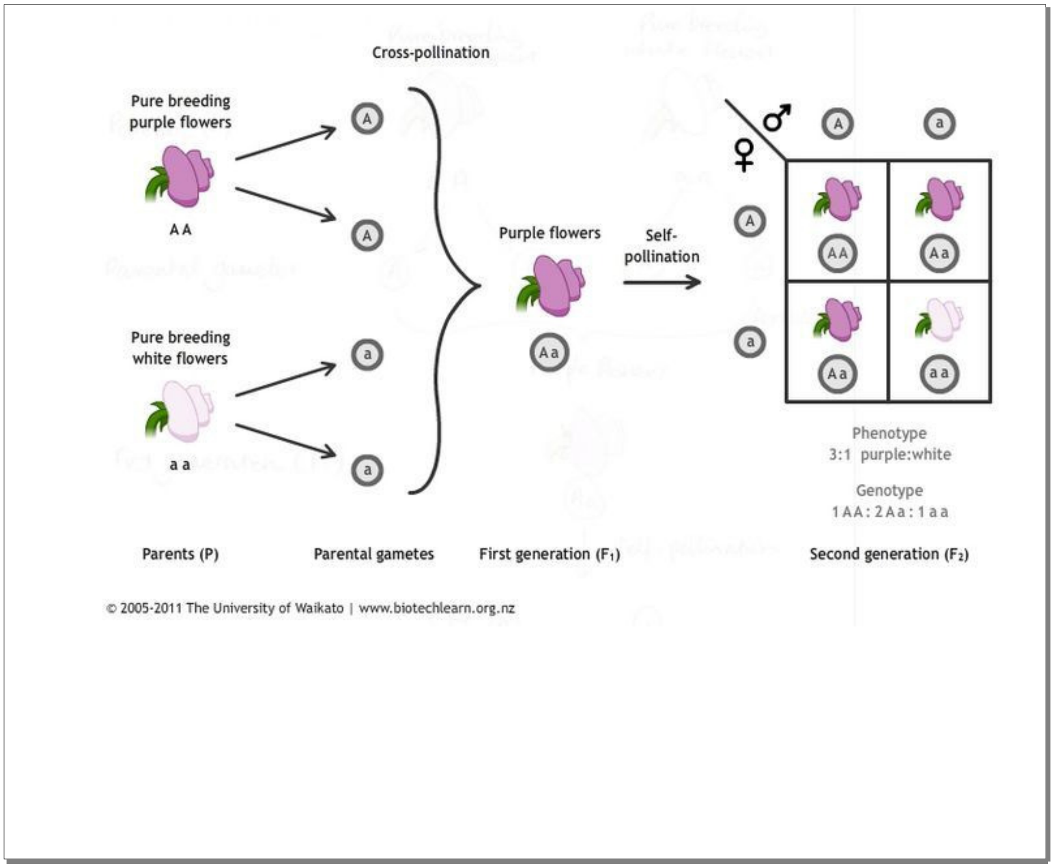


2) For example, Mendel crossed a true-breeding yellow-seeded plant with a true-breeding green-seeded plant to produce plants of the F_1 generation, all of which had yellow seeds.



D) Creating the **F_2 generation**

1) The second "Filial" generation (F_2) was the result of self-pollinating an F_1 plant.
2) For example, offspring from a self-pollinated purple pea plant from the F_1 generation (so it was heterozygous, not true-breeding) were a mix of 75% purple flowers and 25% white flowers.

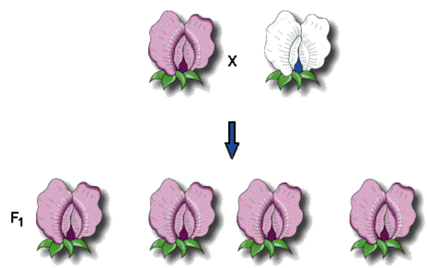


IV) Mendel's Laws

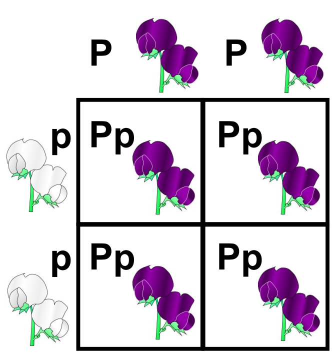
A) **Law of Dominance**: when two pure-bred individuals with different versions of a trait are crossed, the offspring will all exhibit the same version of the trait

1) This means that one trait is always *dominant* over the other

2) Organisms that are heterozygous have the appearance (phenotype) of the allele that is dominant. Example: purple flowers (P) are dominant to white (p); a plant with the genotype Pp will have purple flowers because purple is dominant to white.



3) The law of dominance can be easily shown in a Punnett square:



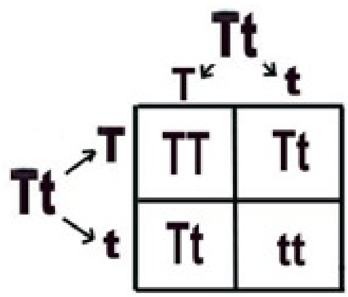
A cross between pure white and pure purple flowers will produce all purple flowers. This is because the allele for purple flowers is dominant over the allele for white flowers.

B) **Law of Segregation**: when reproductive cells are made, the two alleles for the same characteristic will separate from each other into different reproductive cells.

1) This means that both alleles have an equal chance of being passed down to the offspring, but only one allele for each characteristic is passed from each parent to their offspring.

2) Remember, Mendel knew nothing about genes or alleles, yet deduced the law of segregation by simply referring to the alleles as "factors" that could be inherited.

3) The law of segregation is shown every time a Punnett square is constructed.

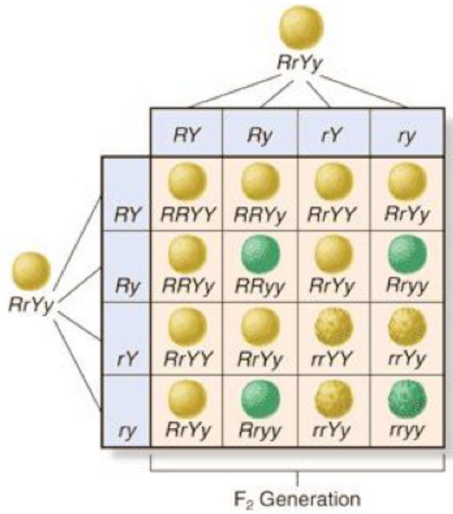


The separation of alleles can be seen across the top and down the side of the Punnett square. Offspring can inherit either the T or t allele from each parent.

C) **Law of Independent Assortment**: alleles for different traits are inherited independently of each other

1) This means that the alleles for flower color do not affect which alleles are inherited for tallness. A pea plant with purple flowers has an equal chance of inheriting the allele for tallness as it does the allele for shortness.

2) This law can be shown in an expanded version of the Punnett square:



This Punnett square shows a cross between two pea plants of the F_1 generation that resulted from crossing purebred peas with round (R) yellow (Y) seeds with purebred peas with wrinkled (r) green (y) seeds. All possible allele combinations for shape and color are listed across the top and down the side. Then the rest of the square is filled in just as you would a "regular" Punnett square. The result of this cross shows that there is a 25% chance of the offspring having green seeds and a 25% chance of the offspring having wrinkled seeds, but all of the green seeds are not necessarily the ones that are wrinkled.