



Inheritance

The passing down of traits

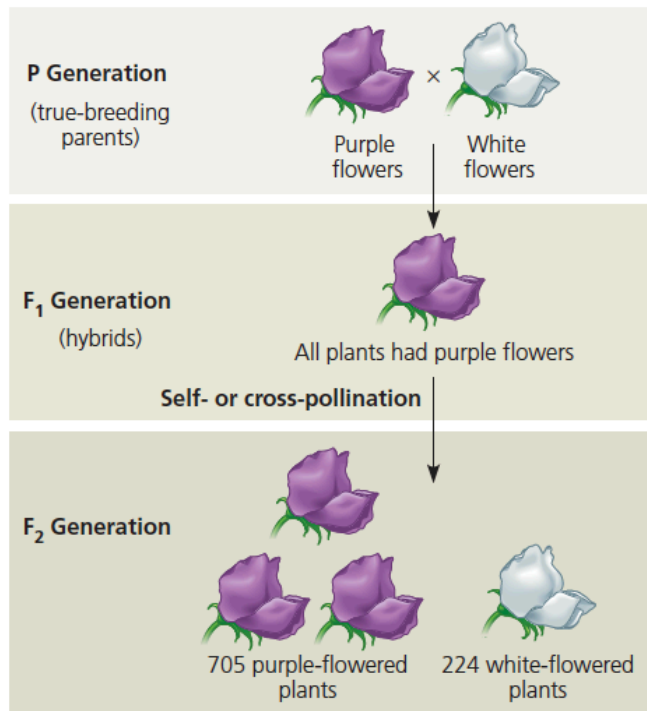
Definitions of Structures

- **Genes** are sequences of nucleotides on a DNA molecule
- **Alleles** are alternative forms of the same gene found on the corresponding gene locus of homologous chromosomes
- **Phenotypes** are the expressed traits in an organism's physical appearance of other attribute
- **Genotypes** are the genetic make-ups of an organism

Mendelian Experiments

Mendel experimented with pea plants as:

- It was possible to control mating with self and cross pollination
- There were many wild phenotypes
- There was a short turnaround time for results



The parental generation are true-breeding plants (they are homozygous dominant or homozygous recessive).

The first filial generation are the offspring of the parental generation. They may have purple flowers but are actually hybrids (possessing a heterozygous genotype)

The second filial generation are the offspring of the first filial generation. They are comprised of 1/4 homozygous dominant, 1/4 homozygous recessive, and 1/2 heterozygous genotypes but 3/4 purple phenotype and 1/4 white phenotype.

The dominant allele is the allele that will express itself and gives the same phenotype in both the homozygous and heterozygous conditions.

The recessive allele is the allele that will express itself only in the homozygous condition. It will fail to express itself in the heterozygous condition.

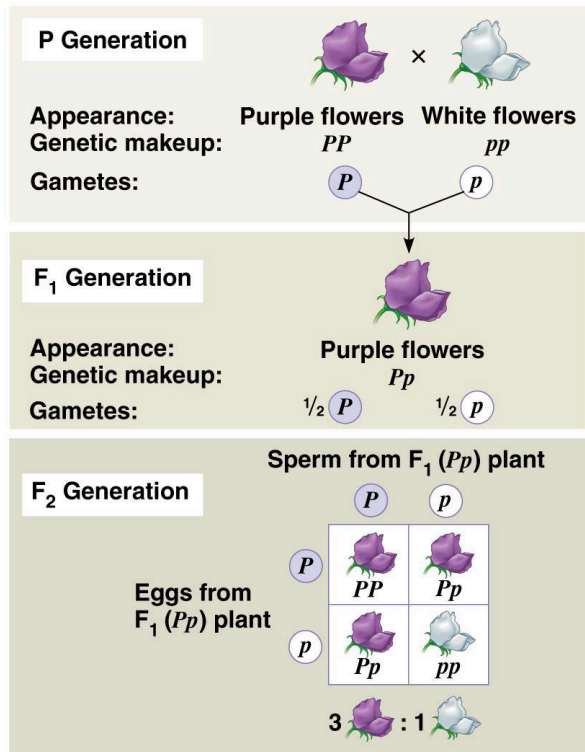
Table 14.1 The Results of Mendel's F ₁ Crosses for Seven Characters in Pea Plants					
Character	Dominant Trait	×	Recessive Trait	F ₂ Generation Dominant: Recessive	Ratio
Flower color	Purple 	×	White 	705:224	3.15:1
Seed color	Yellow 	×	Green 	6,022:2,001	3.01:1
Seed shape	Round 	×	Wrinkled 	5,474:1,850	2.96:1
Pod color	Green 	×	Yellow 	428:152	2.82:1
Pod shape	Inflated 	×	Constricted 	882:299	2.95:1
Flower position	Axial 	×	Terminal 	651:207	3.14:1
Stem length	Tall 	×	Dwarf 	787:277	2.84:1

Mendelian Principles

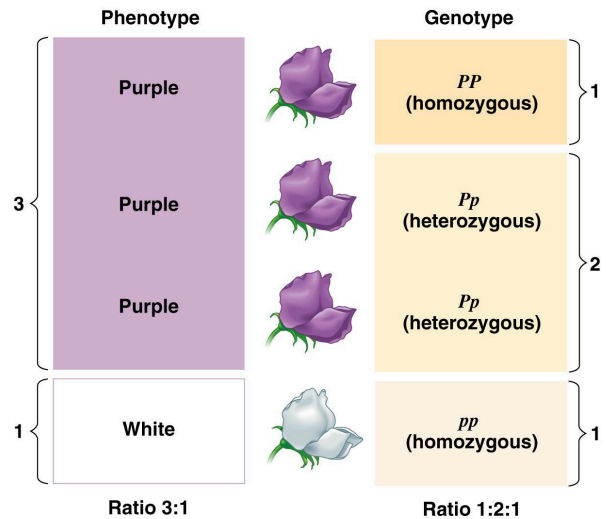
- Alternate version of genes (alleles) cause variations in inherited characteristics among offspring
- For each character, every organism inherits one allele from each parent
- If 2 alleles are different, the dominant allele will be fully expressed; the recessive allele will have no noticeable effect on the offspring's appearance

- Mendel's First Law: The Law of Segregation - the 2 alleles for each character separate during gamete formation

The Law of Segregation

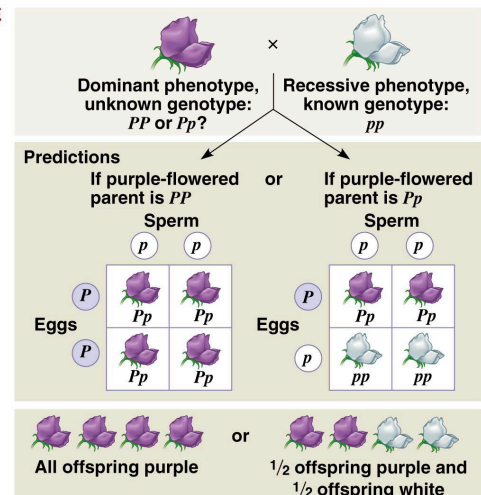


In order to determine the zygosity of an organism for a particular trait, a Mendelian testcross may be conducted where an organism of unknown genotype (homozygous dominant or heterozygous) expressing the dominant phenotype is crossed with an organism of known genotype (homozygous recessive) expressing the recessive phenotype.



The phenotype consists of the expressed physical traits whereas the genotype consists of the genetic make-up of the organism.

TECHNIQUE



Non-Mendelian Genetics

Mendelian genetics imply complete dominance, where the heterozygote and homozygote for the dominant allele are indistinguishable in phenotype.

However, some species and genes express genes in a non-Mendelian character.

Incomplete Dominance

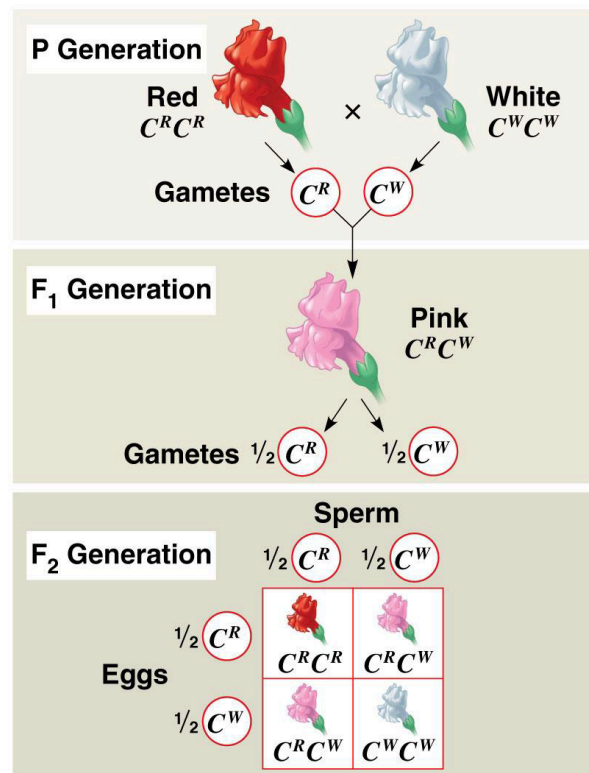
The first filial generation's hybrids have an appearance that is "in between" that of its parents as no allele is dominant over the other - instead causing syncretised offspring.

The adjacent example on red and white flowers mating to produce a pink flower is an example of incomplete dominance.

Codominance

Where codominance is displayed, in the heterozygous condition, both alleles have an equal effect on the phenotype.

An example is that of calico cats



Multiple Alleles

(a) The three alleles for the ABO blood groups and their carbohydrates. Each allele codes for an enzyme that may add a specific carbohydrate (designated by the superscript on the allele and shown as a triangle or circle) to red blood cells.			
Allele	I^A	I^B	i
Carbohydrate	A 	B 	none

(b) Blood group genotypes and phenotypes. There are six possible genotypes, resulting in four different phenotypes.				
Genotype	$I^A I^A$ or $I^A i$	$I^B I^B$ or $I^B i$	$I^A I^B$	ii
Red blood cell with surface carbohydrates				
Phenotype (blood group)	A	B	AB	O

An example of a phenotype affected by one gene of multiple (> 2) alleles is that of human blood groups.

A - $I^A I^A$ (homozygous dominant) or $I^A i / I^A i^0$ (heterozygous)

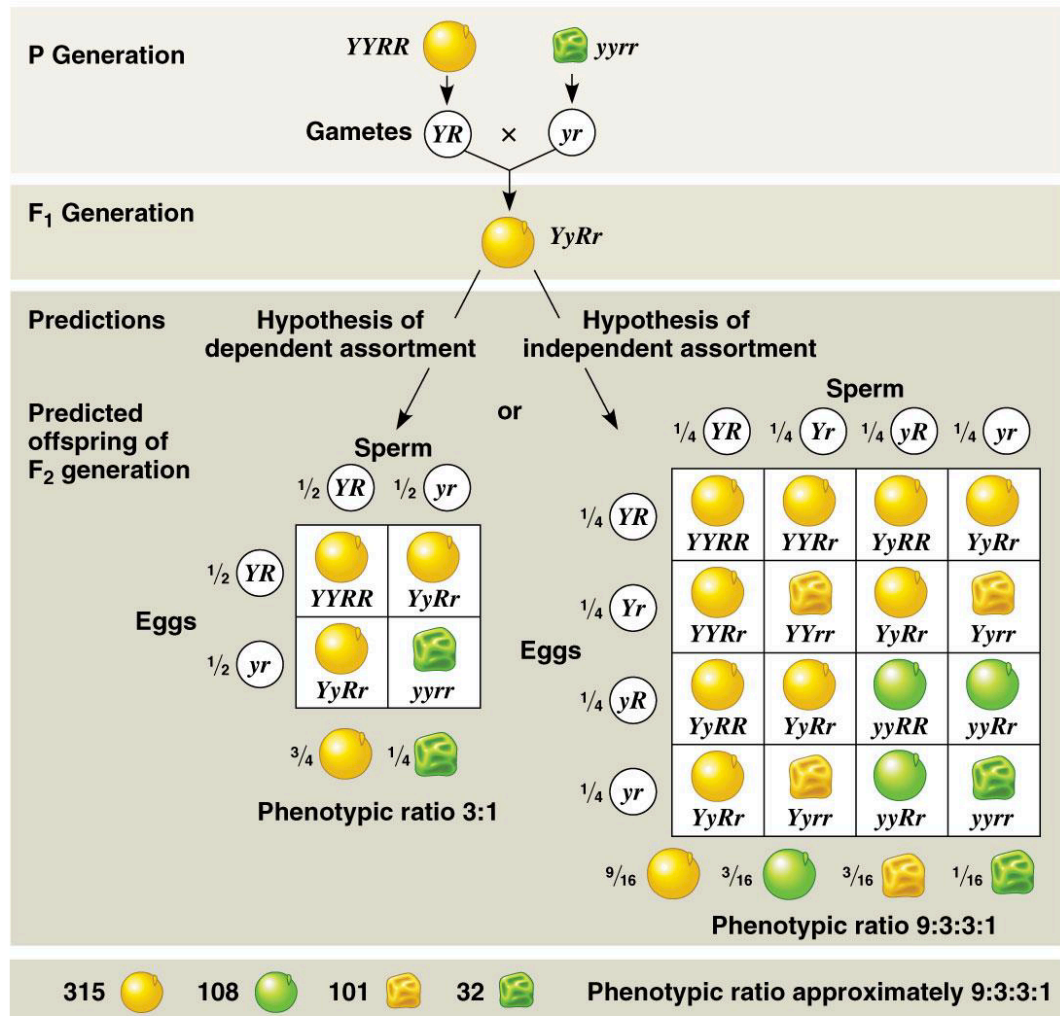
B - $I^B I^B$ (homozygous dominant) or $I^B i / I^B i^0$ (heterozygous)

AB - $I^A I^B$ (codominant)

O - $ii / I^0 I^0$ (homozygous recessive)

The Law of Independent Assortment

EXPERIMENT



The Law of Independent Assortment dictates that each pair of alleles segregates independently during gamete formation

The dihybrid cross may be used to determine phenotypic ratios in accordance to Mendel's second law.

Variations

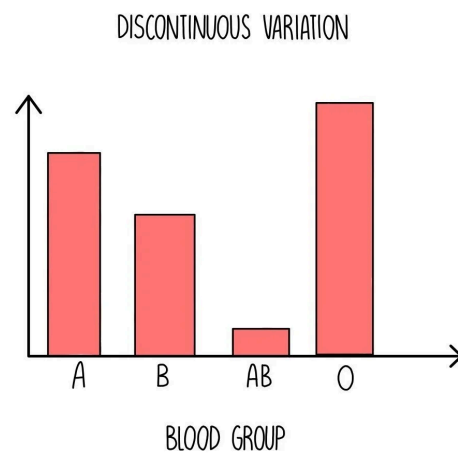
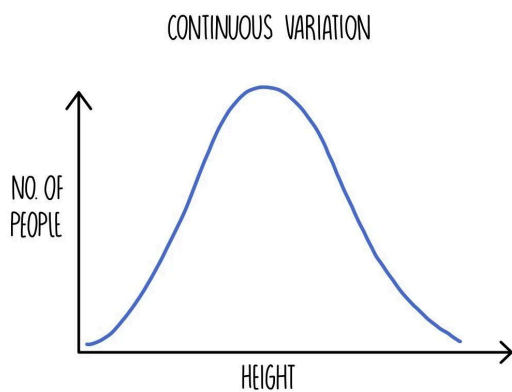


Variations are differences in traits between individuals of the same species

Traits of individuals are dependent on genetic and environmental interactions. Genetic variations are inheritable whereas variations caused by the environment are not.

- **Discontinuous Variation** is brought about by one or a few genes at most
- **Continuous Variation** is brought about by the additive effect of many genes

For example, with the traits of height and blood groups:



Continuous Variation	Discontinuous Variation
Deals with a range of phenotypes	Deals with a few clear-cut phenotypes
Controlled by many genes	Controlled by one or a few genes
Genes show an additive effect	Genes do not show an additive effect
Affected by environmental conditions	Unaffected by environmental conditions

Continuous Variation examples:

Height/Weight

Hand size

Skin Color

Discontinuous Variation examples:

Blood Type (O,A,B,AB)

Gender (Male/Female)

Presence of dimples /Absence of dimples

Types of Inheritance

Autosomal Inheritance

Autosomal Dominant

Only one mutated allele is needed for the disease to show

Cannot skip generations

Parents **MUST** be heterozygous

Autosomal Recessive

Both mutated alleles are needed for the disease to show

Can skip generations due to carriers

Parents **MUST** be heterozygous

X-linked Inheritance

X-Linked Dominant

Only one X chromosome needed to contain mutated allele

Affected father's daughters will always be affected (since at least one X has to come from father).

X-Linked Recessive

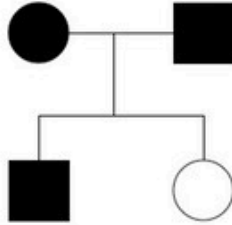
All X chromosomes inherited have to contain the mutated allele

More present in males (XY) than females (XX)

Males cannot be carriers

if Mother is affected (not carrier), all sons will be affected.

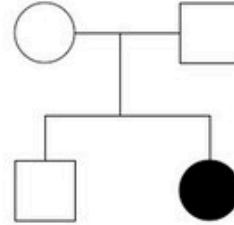
Diagrams:



Autosomal Dominant

Cannot be recessive as affected parents could not have an unaffected offspring

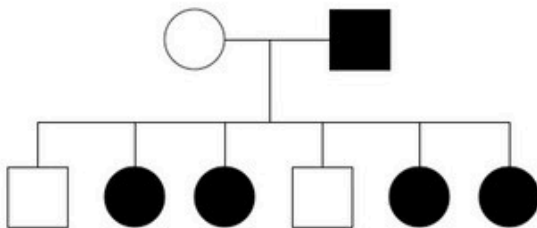
Parents MUST be heterozygous



Autosomal Recessive

Cannot be dominant as unaffected parents could not have an affected offspring

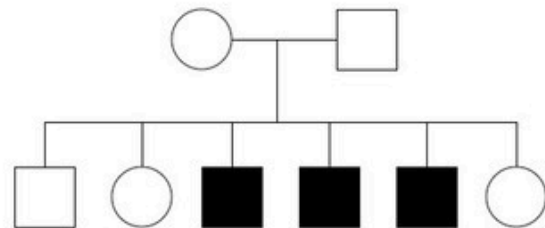
Parents MUST be heterozygous



X-Linked Dominant

Mode of inheritance cannot be confirmed

However, 100% incidence of affected daughters from an affected father suggests X-linked dominant inheritance



X-Linked Recessive

Sex linkage cannot be confirmed

However, high incidence of affected sons suggests X-linked recessive inheritance

