

CHECKLIST UNIT: MENDEL AND THE GENE IDEA

Mendel stated that each individual has **two factors (genes)** for each trait, one from each parent. The two genes may or may not contain the same information. If the two genes for a trait are identical, the individual is called **homozygous** for that trait. If the two genes have different information, the individual is called **heterozygous** with regards to that trait. The different possible forms of a gene are called **alleles**. The **genotype** of an individual is made up of the many alleles it possesses.

An individual's physical appearance, or **phenotype**, is determined by its alleles as well as by its **environment**.

Mendel summarized his findings in two laws; the **Law of Segregation** and the **Law of Independent Assortment**. (**Law of segregation**. During gamete formation, the alleles for each gene segregate from each other so that each gamete carries only one allele for each gene. **Law of independent assortment**. Genes of different traits can segregate independently during the formation of gametes.)

MAIN KEY TERMS

Carrier	homozygous	phenotype
codominance	hybridization	pleiotropy
complete dominance	incomplete dominance	polygenic inheritance
dihybrid	law of independent	Punnett square
dominant allele	assortment	recessive allele
epistasis	law of segregation	test cross
F1 generation	monohybrid	trait
F2 generation	P generation	true-breeding
heterozygous	pedigree	

ROOT WORDS TO KNOW ¹

co- = together (*codominance*: phenotype in which both dominant alleles are expressed in the heterozygote)

di- = two (*dihybrid cross*: a breeding experiment in which offspring of a cross of parental varieties differing in two traits are mated)

epi- = beside; **-stasis** = standing (*epistasis*: a phenomenon in which one gene alters the expression of another gene that is independently inherited)

geno- = offspring (*genotype*: the genetic makeup of an organism)

hetero- = different (*heterozygous*: having two different alleles for a trait)

homo- = alike (*homozygous*: having two identical alleles for a trait)

mono- = one (*monohybrid cross*: a breeding experiment that crosses offspring of a cross of parental varieties differing in a single character)

pedi- = a child (*pedigree*: a family tree describing the occurrence of heritable characters in parents and offspring across as many generations as possible)

pheno- = appear (*phenotype*: the physical and physiological traits of an organism)

pleio- = more (*pleiotropy*: when a single gene impacts more than one characteristic)

poly- = many; **gene-** = produce (*polygenic*: an additive effect of two or more gene loci on a single phenotypic character)

Concept 14.1 Mendel used the scientific approach to identify two laws of inheritance

Pea plants are available in many varieties with distinct heritable features, or **characters**, with different variant **traits**.

- Mendel started his experiments with varieties that were **true-breeding**.
 - When true-breeding plants self-pollinate, all their offspring have the same traits.
- Mendel would cross-pollinate (**hybridize**) two contrasting, true-breeding pea varieties.
 - The true-breeding parents (**P generation**) gave hybrid offspring (the **F₁ generation**).

Law of segregation: the two alleles for a character separate during the formation of gametes.

- These alternate versions are called **alleles**.
- A **Punnett square** predicts the results of a genetic cross between individuals
- An organism with two identical alleles for a character is **homozygous** for that character.
- Organisms with two different alleles for a character is **heterozygous** for that character.

Law of independent assortment: each pair of alleles segregates independently into gametes.

- *Single character* = All F₁ progeny produced were **monohybrids**, heterozygous for one character.
- **dihybrid cross**, Mendel studied the inheritance of two characters
- Mendel's law of independent assortment states that *each pair of alleles segregates independently during gamete formation*. (Strictly speaking, this law applies only to genes located on different, **nonhomologous** chromosomes.)

Concept 14.2 The laws of probability govern Mendelian inheritance

- Mendel's laws of segregation and independent assortment reflect the same laws of probability.

Concept 14.3 Inheritance patterns are often more complex than predicted by simple Mendelian genetics

- In the 20th century, geneticists have extended Mendelian principles not only to diverse organisms, but also to patterns of inheritance more complex than Mendel described.
- In fact, Mendel had the good fortune to choose a system that was relatively simple.
 - *Each character that Mendel studied is controlled by a single gene.*
 - *Each gene has only two alleles, one of which is completely dominant to the other.*
- Alleles show different degrees of **dominance** and **recessiveness** in relation to each other.
- One extreme is the **complete dominance** characteristic of Mendel's crosses.
- At the other extreme from complete dominance is **codominance**, in which two alleles affect the phenotype in separate, distinguishable ways.
- A clear example of incomplete dominance is seen in flower color of snapdragons.
A cross between a white-flowered plant and a red-flowered plant will produce all pink F₁ offspring.
Self-pollination of the F₁ offspring produces 25% white, 25% red, and 50% pink F₂ offspring.

The **ABO blood groups** in humans are determined by three alleles, I^A , I^B , and i .

Both the I^A and I^B alleles are dominant to the i allele; The I^A and I^B alleles are codominant.

Because each individual carries two alleles, there are six possible genotypes and four possible blood types.

Individuals that are $I^A I^A$ or $I^A i$ are type A and have type A carbohydrates on the surface of their red blood cells.

Individuals that are $I^B I^B$ or $I^B i$ are type B and have type B carbohydrates on the surface of their red blood cells.

Individuals that are $I^A I^B$ are type AB and have both type A and type B carbohydrates on the surface of their red blood cells.

Individuals that are ii are type O and have neither carbohydrate on the surface of their red blood cells.

However, most genes are **pleiotropic**, affecting more than one phenotypic character.