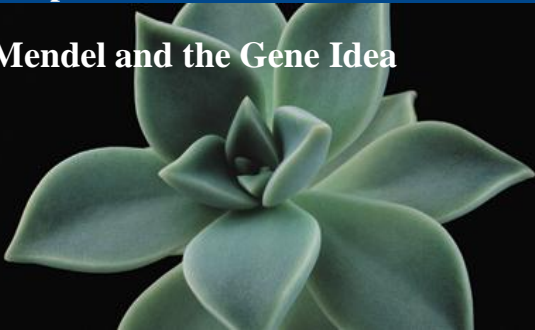


Chapter 14

Mendel and the Gene Idea



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

- Mendel discovered the basic principles of heredity by breeding garden peas in carefully planned experiments



1822-1884

Mendel's Experimental, Quantitative Approach

- Advantages of pea plants for genetic study:
 - There are many varieties with distinct heritable features, or **characters** (such as flower color); character variants (such as purple or white flowers) are called **traits**
 - Each pea plant has sperm-producing organs (stamens) and egg-producing organs (carpels)
 - Cross-pollination (fertilization between different plants) can be achieved by dusting one plant with pollen from another

Figure 14.2a

TECHNIQUE

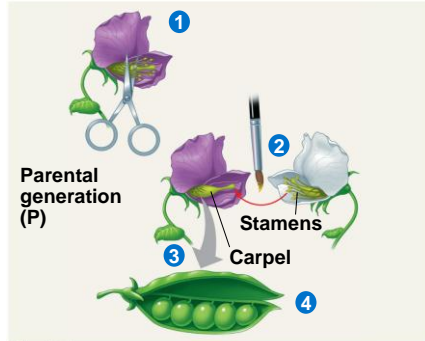


Figure 14.2b

RESULTS

First filial generation offspring (F₁)

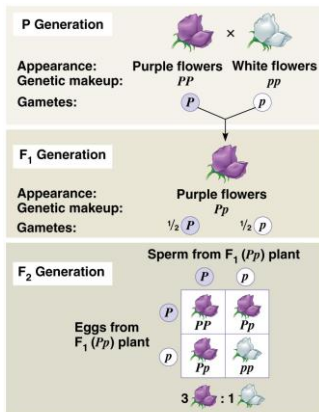
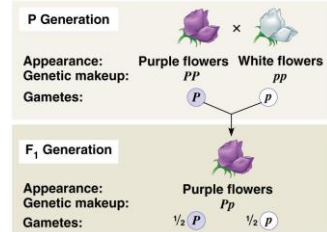
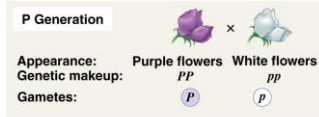


- Mendel chose to track only those characters that varied in an either-or manner
- He also used varieties that were **true-breeding** (plants that produce offspring of the same variety when they self-pollinate)

- In a typical experiment, Mendel mated two contrasting, true-breeding varieties, a process called **hybridization**
- The true-breeding parents are the **P generation**
- The hybrid offspring of the P generation are called the **F₁ generation**
- When F₁ individuals self-pollinate, the **F₂ generation** is produced

The Law of Segregation

- When Mendel crossed contrasting, true-breeding white and purple flowered pea plants, all of the F₁ hybrids were purple
- When Mendel crossed the F₁ hybrids, many of the F₂ plants had purple flowers, but some had white
- Mendel discovered a ratio of about three to one, purple to white flowers, in the F₂ generation

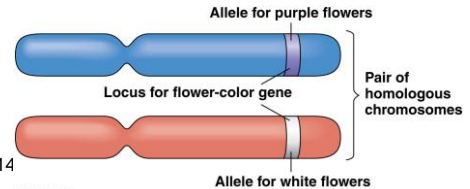


- Mendel reasoned that only the purple flower factor was affecting flower color in the F₁ hybrids
- Mendel called the purple flower color a dominant trait and the white flower color a recessive trait
- Mendel observed the same pattern of inheritance in six other pea plant characters, each represented by two traits
- What Mendel called a “heritable factor” is what we now call a gene

Mendel's Model

- Mendel developed a hypothesis to explain the 3:1 inheritance pattern he observed in F_2 offspring
- Four related concepts make up this model

- The first concept is that alternative versions of genes account for variations in inherited characters
- These alternative versions of a gene are now called **alleles**



- The second concept is that for each character an organism inherits two alleles, one from each parent
- The two alleles at a locus on a chromosome may be identical, as in the true-breeding plants of Mendel's P generation
- Alternatively, the two alleles at a locus may differ, as in the F_1 hybrids

- The third concept is that if the two alleles at a locus differ, then one (the **dominant allele**) determines the organism's appearance, and the other (the **recessive allele**) has no noticeable effect on appearance
- In the flower-color example, the F_1 plants had purple flowers because the allele for that trait is dominant

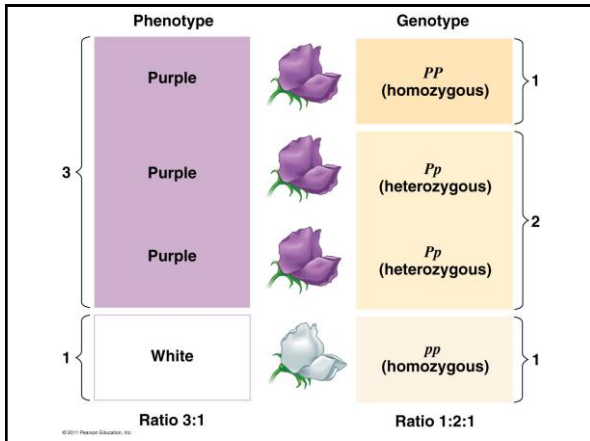
- The fourth concept, now known as the **law of segregation**, states that the two alleles for a heritable character separate (segregate) during gamete formation and end up in different gametes
- Thus, an egg or a sperm gets only one of the two alleles that are present in the somatic cells of an organism
- This segregation of alleles corresponds to the distribution of homologous chromosomes to different gametes in meiosis

- Mendel's segregation model accounts for the 3:1 ratio he observed in the F_2 generation of his numerous crosses
- The possible combinations of sperm and egg can be shown using a **Punnett square**, a diagram for predicting the results of a genetic cross between individuals of known genetic makeup
- A capital letter represents a dominant allele, and a lowercase letter represents a recessive allele

Useful Genetic Vocabulary

- An organism with two identical alleles for a character is said to be **homozygous** for the gene controlling that character
- An organism that has two different alleles for a gene is said to be **heterozygous** for the gene controlling that character
- Unlike homozygotes, heterozygotes are not true-breeding

- Because of the different effects of dominant and recessive alleles, an organism's traits do not always reveal its genetic composition
- Therefore, we distinguish between an organism's **phenotype**, or physical appearance, and its **genotype**, or genetic makeup
- In the example of flower color in pea plants, PP and Pp plants have the same phenotype (purple) but different genotypes



Degrees of Dominance

- Complete dominance occurs when phenotypes of the heterozygote and dominant homozygote are identical
- In incomplete dominance, the phenotype of F_1 hybrids is somewhere between the phenotypes of the two parental varieties
- In codominance, two dominant alleles affect the phenotype in separate, distinguishable ways

