

Mendelism

Classical Genetics



Mendel's Legacy & Genetic Crosses

Objectives

- ▣ **Describe** how Mendel was able to control how his pea plants were pollinated.
- ▣ **Describe** the steps in Mendel's experiments on true-breeding garden peas.
- ▣ **Distinguish** between dominant and recessive traits.
- ▣ **State** two laws of heredity that were developed from Mendel's work.
- ▣ **Describe** how Mendel's results can be explained by scientific knowledge of genes and chromosomes.

Gregor Mendel

- ▣ The study of how characteristics are transmitted from parents to offspring is called **genetics**.

Gregor Mendel

- ▣ **Mendel's Garden Peas**
 - Mendel observed characteristics of pea plants.
 - **Traits**
 - ▣ genetically determined variants of a characteristic.
 - ▣ Each characteristic occurred in two contrasting traits.

Gregor Mendel

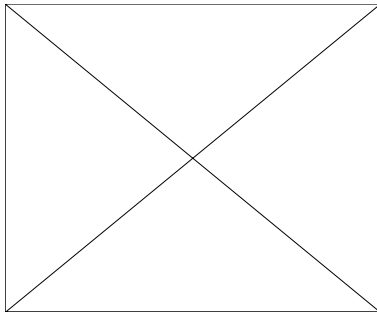
Mendel's Methods

- ▣ Mendel used **cross-pollination** techniques
 - pollen is transferred between flowers of two different plants

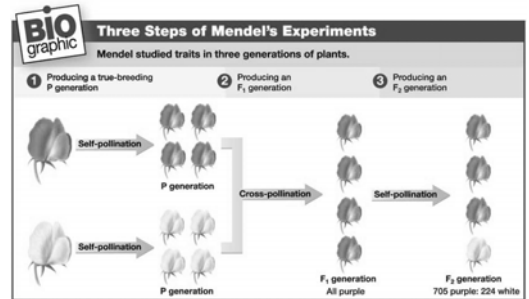
Mendel's Experiments

- ▣ Mendel bred plants for several generations that were true-breeding for specific traits and called these the **P generation**.
- ▣ Offspring of the P generation were called the **F₁ generation**.
- ▣ Offspring of the F₁ generation were called the **F₂ generation**.

Mendel's Experiments



Three Steps of Mendel's Experiments



Mendel's Results and Conclusions

- ▣ **Recessive and Dominant Traits**
 - Mendel concluded that inherited characteristics are controlled by factors that occur in pairs.
 - Through experimentation he found one factor in a pair masked the other
 - The trait that masked the other was called the **dominant** trait.
 - The trait that was masked was called the **recessive** trait.

Mendel's Results and Conclusions

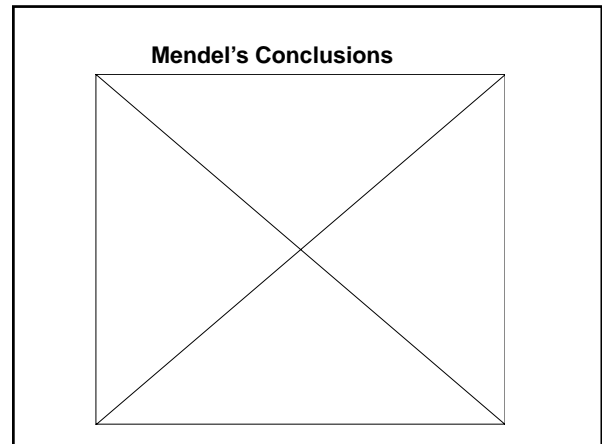
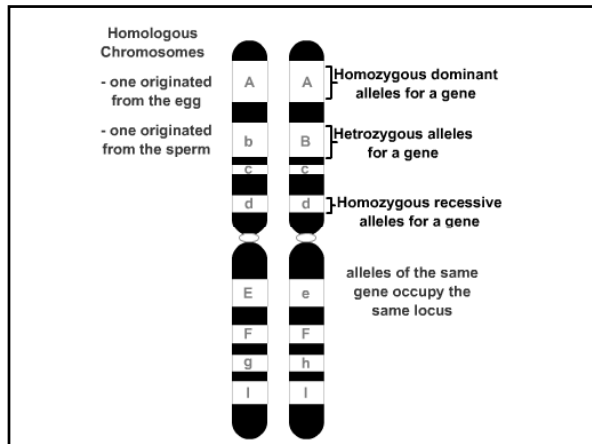
- ▣ **The Law of Segregation**
 - The **law of segregation** states that a pair of factors is segregated, or separated, during the formation of gametes.

Mendel's Results and Conclusions

- ▣ **The Law of Independent Assortment**
 - ...states that factors for individual characteristics are distributed to gametes **independent of one another**.
 - ...is observed only for genes that are located on separate chromosomes or are far apart on the same chromosome.

Support for Mendel's Conclusions

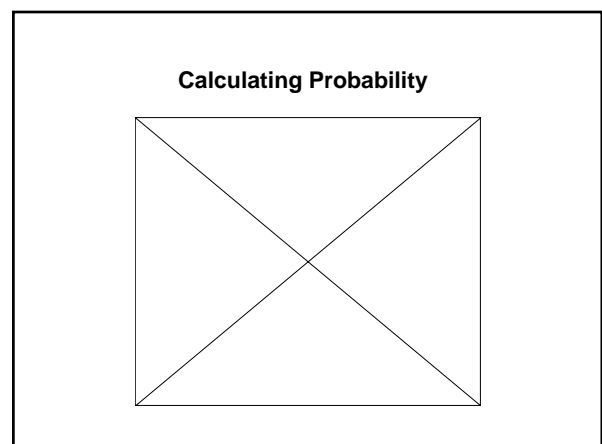
- ▣ The *factors* that Mendel studied are **alleles**, or alternative forms of a gene.
- ▣ One allele for each trait is passed from each parent to the offspring.



- ### Objectives
- **Differentiate** between the genotype and the phenotype of an organism.
 - **Explain** how probability is used to predict the results of genetic crosses.
 - **Use** a Punnett square to predict the results of monohybrid and dihybrid genetic crosses.
 - **Explain** how a testcross is used to show the genotype of an individual whose phenotype expresses the dominant trait.
 - **Differentiate** a monohybrid cross from a dihybrid cross.

- ### Genotype and Phenotype
- The **genotype** is the genetic makeup of an organism.
 - Aa or aa or AA
 - The **phenotype** is the appearance of an organism.
 - What you see

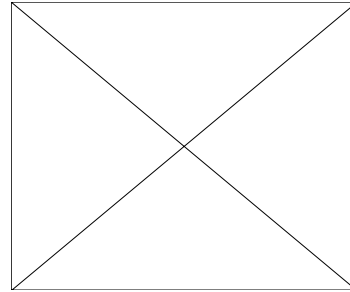
- ### Probability
- **Probability** is the likelihood that a specific event will occur.
 - A probability may be expressed as a decimal, a percentage, or a fraction.



Predicting Results of Monohybrid Crosses

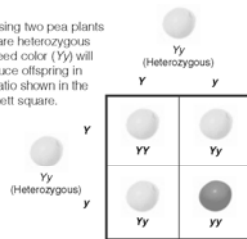
- A **Punnett square** can be used to predict the outcome of genetic crosses.
- A cross in which one characteristic is tracked is a **monohybrid cross**.

Punnett Square with Homozygous Cross



Monohybrid Cross of Heterozygous Plants

Crossing two pea plants that are heterozygous for seed color (Yy) will produce offspring in the ratio shown in the Punnett square.

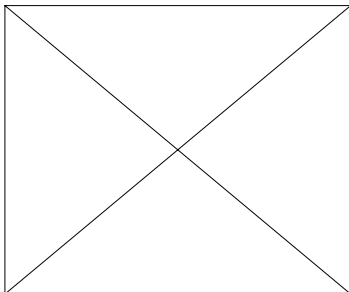


$\frac{1}{4}$ = YY (Homozygous dominant)
 $\frac{2}{4}$ = Yy (Heterozygous)
 $\frac{1}{4}$ = yy (Homozygous recessive)

Predicting Results of Monohybrid Crosses

- **Testcross**
 - Example: an individual of unknown genotype is crossed with a homozygous recessive individual
 - Testcross can be used to determine the genotype of an individual whose phenotype expresses the dominant trait

Testcross



Predicting Results of Monohybrid Crosses

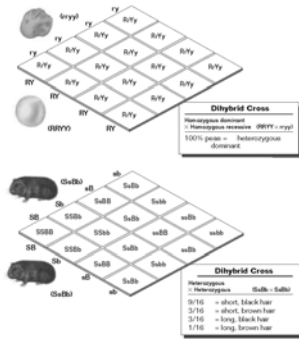
- **Complete dominance**
 - occurs when heterozygous individuals and dominant homozygous individuals are indistinguishable in phenotype.
- **Incomplete dominance**
 - occurs when two or more alleles influence the phenotype and results in a phenotype intermediate between the dominant trait and the recessive trait.

Predicting Results of Monohybrid Crosses

- **Codominance** occurs when both alleles for a gene are expressed in a heterozygous offspring.

Dihybrid Cross

A cross where two characteristics are tracked is a **dihybrid cross**



Multiple Choice

1. What is a procedure in which an individual of unknown genotype is crossed with a homozygous recessive individual to determine the genotype of the unknown individual called?
A. a monohybrid cross
B. a dihybrid cross
C. a hybrid cross
D. a testcross

Multiple Choice, *continued*

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C. a hybrid cross
D. a testcross

Multiple Choice, *continued*

2. In a monohybrid cross of two heterozygous parents (Pp), what would the expected genotypes of the offspring be?
F. 1 PP : 2 Pp : 1 pp
G. 1 pp : 3 PP
H. 3 Pp : 1 pp
J. all Pp

Multiple Choice, *continued*

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Multiple Choice, *continued*

3. Which of the following is an example of a genotype of a heterozygous individual?
- A. p
 - B. YY
 - C. Zz
 - D. rr

Multiple Choice, *continued*

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Multiple Choice, *continued*

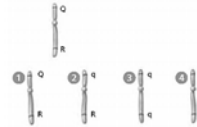
Use the diagrams of chromosomes below to answer the question that follows. The single chromosome below has two genes, both of which carry a dominant allele Q and R.



4. Homologous chromosomes are chromosomes that carry genes for the same characteristics, such as eye color or hair color. Which of the chromosomes in the bottom row could not be the homologous chromosome for the single chromosome in the top row?
- F. 1
 - G. 2
 - H. 3
 - J. 4

Multiple Choice, *continued*

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 - H. 3
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Multiple Choice, *continued*

5. Rr : genotype :: red :
- A. F1 generation
 - B. heterozygote
 - C. phenotype
 - D. dominant

Multiple Choice, *continued*

5. Rr : genotype :: red :
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 - B. heterozygote
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Multiple Choice, *continued*

Use the diagram of a Punnett square below to answer the question that follows.



6. The Punnett square shows the expected results of a cross between two pea plants. R and r represent the alleles for round seed and wrinkled seed traits, respectively. What would the seed texture phenotype of the plant in box 4 be?
- F. round
 - G. Rr
 - H. wrinkled
 - J. rr

Multiple Choice, *continued*

Use the diagram of a Punnett square below to answer the question that follows.



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 - J. rr

Short Response

Mendel was able to observe certain traits as they were passed on by carefully controlling how the pea plants were pollinated. Explain why Mendel began his experiments by allowing pea plants to self-pollinate for several generations.

Short Response, *continued*

Mendel was able to observe certain traits as they were passed on by carefully controlling how the pea plants were pollinated. Explain why Mendel began his experiments by allowing pea plants to self-pollinate for several generations.

Answer:

Mendel wanted to ensure that the plants he was studying were true-breeding.

Extended Response

A cross between two pea plants that have axial flowers and inflated pods gives the following offspring: 20 that have axial flowers and inflated pods, 7 with axial flowers and constricted pods, and 5 that have terminal flowers and inflated pods.

Part A Identify the most probable genotype of the two parents.

Part B Use a Punnett square to explain the results.

Extended Response, *continued*

Answer:

Part A The ratio of offspring phenotypes is very close to the expected ratios (9:3:3:1) of a dihybrid heterozygous cross. The most likely genotype of the parents is AaIi.

Part B The Punnett square yields 9 different genotypes and 4 phenotypes.

