

# Genetics & The Work of Mendel

## Gregor Mendel

- Modern genetics began in the mid-1800s in an abbey garden, where a monk named Gregor Mendel documented inheritance in peas
- ♦ used experimental method
- ♦ used quantitative analysis
  - collected data & counted them
- ♦ excellent example of scientific method

## Mendel's work

- Bred pea plants
  - ♦ cross-pollinate **true breeding parents (P)**
    - **P = parental**
  - ♦ raised seed & then observed traits (**F<sub>1</sub>**)
    - **F = filial**
  - ♦ allowed offspring to **self-pollinate** & observed next generation (**F<sub>2</sub>**)

## Mendel collected data for 7 pea traits

Table 11.1 Seven Characters Mendel Studied and His Experimental Results

Character		F <sub>1</sub> Generation	
Dominant Form	Recessive Form	Dominant/Recessive	Ratio
Purple flowers	White flowers	795/274	3:1
Yellow seeds	Green seeds	602/200	3:1
Round seeds	Wrinkled seeds	547/180	3:1
Green pods	Yellow pods	428/132	3:1
Inflated pods	Constricted pods	882/299	3:1
Axial flowers	Terminal flowers	651/207	3:1
Tall plants	Dwarf plants	787/277	3:1

## Looking closer at Mendel's work

**P generation:** true-breeding purple-flower peas × true-breeding white-flower peas

**F<sub>1</sub> generation (hybrids):** 100% purple-flower peas

**F<sub>2</sub> generation:** 75% purple-flower peas, 25% white-flower peas (3:1 ratio)

Annotations: "Where did the white flowers go?" and "White flowers came back!"

## What did Mendel's findings mean?

- Traits come in alternative versions
  - ♦ purple vs. white flower color
  - ♦ **alleles**
    - different alleles vary in the sequence of **nucleotides** at the specific **locus** of a gene
    - ♦ some difference in sequence of A, T, C, G

**purple-flower allele & white-flower allele are two DNA variations at flower-color locus**

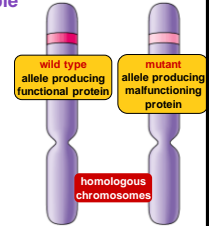
different versions of gene at same location on homologous chromosomes

## Traits are inherited as discrete units

- For each characteristic, an organism inherits 2 alleles, 1 from each parent
  - diploid** organism
    - inherits 2 sets of chromosomes, 1 from each parent
    - homologous chromosomes
    - like having 2 editions of encyclopedia
      - Encyclopedia Britannica
      - Encyclopedia Americana

## What did Mendel's findings mean?

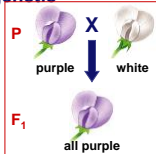
- Some traits mask others
  - purple** & **white** flower colors are separate traits that do not blend
    - purple x white ≠ light purple
    - purple **masked** white
  - dominant allele**
    - functional protein
    - masks other alleles
  - recessive allele**
    - allele makes a malfunctioning protein



## Genotype vs. phenotype

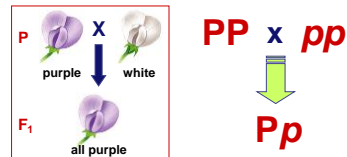
- Difference between how an organism "looks" & its genetics
  - phenotype**
    - description of an organism's trait
    - the "physical"
  - genotype**
    - description of an organism's genetic makeup

Explain Mendel's results using  
...dominant & recessive  
...phenotype & genotype

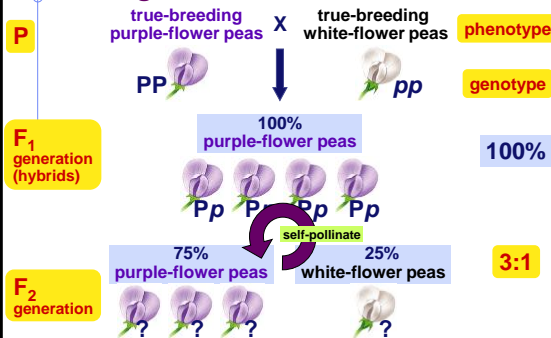


## Making crosses

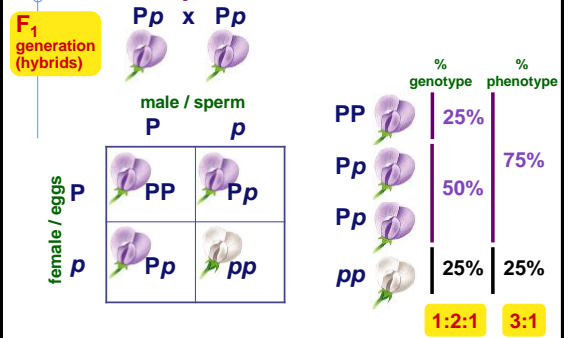
- Can represent alleles as letters
  - flower color alleles → **P** or **p**
  - true-breeding purple-flower peas → **PP**
  - true-breeding white-flower peas → **pp**



## Looking closer at Mendel's work

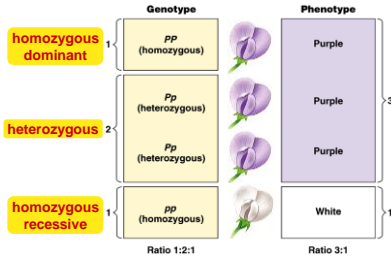


## Punnett squares



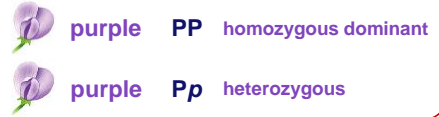
## Genotypes

- **Homozygous** = *same* alleles = **PP, pp**
- **Heterozygous** = *different* alleles = **Pp**



## Phenotype vs. genotype

- 2 organisms can have the same phenotype but have different genotypes



How do you determine the genotype of an individual with a dominant phenotype?



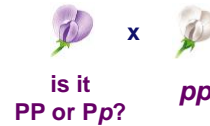
## Dominant phenotypes

- It is not possible to determine the genotype of an organism with a dominant phenotype by looking at it.

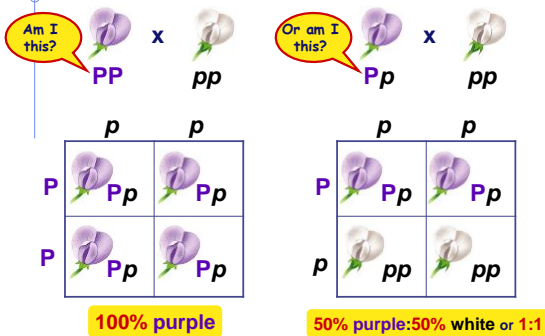


## Test cross

- Breed the dominant phenotype — the unknown genotype — with a **homozygous recessive (pp)** to determine the identity of the unknown allele

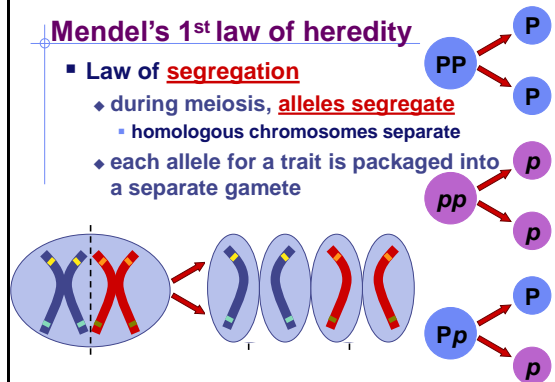


## How does a Test cross work?



## Mendel's 1st law of heredity

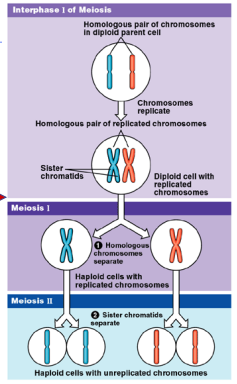
- Law of **segregation**
  - ♦ during meiosis, **alleles segregate**
    - homologous chromosomes separate
  - ♦ each allele for a trait is packaged into a separate gamete



## Law of Segregation

- Which stage of meiosis creates the law of segregation?

Metaphase I

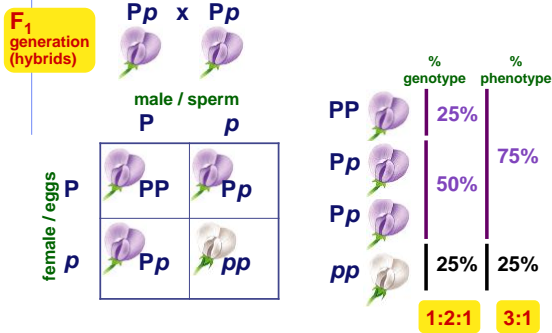


## Monohybrid cross

- Some of Mendel's experiments followed the inheritance of single characters
  - flower color
  - seed color
  - monohybrid** crosses

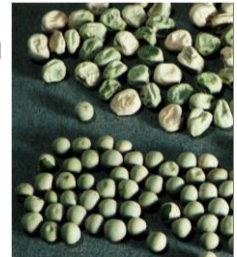


## Monohybrid Punnett squares

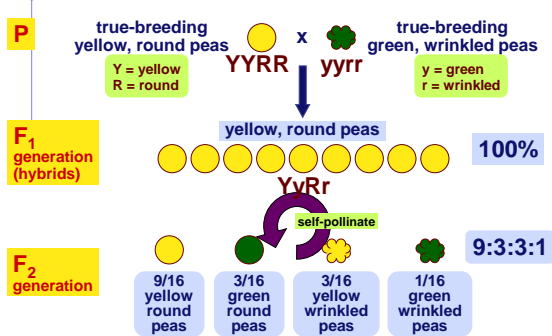


## Dihybrid cross

- Other of Mendel's experiments followed the inheritance of 2 different characters
  - seed color **and** seed shape
  - dihybrid** crosses

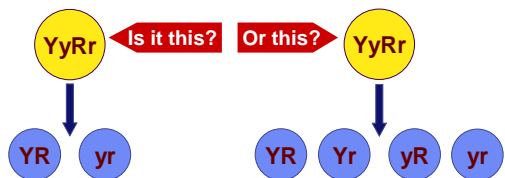


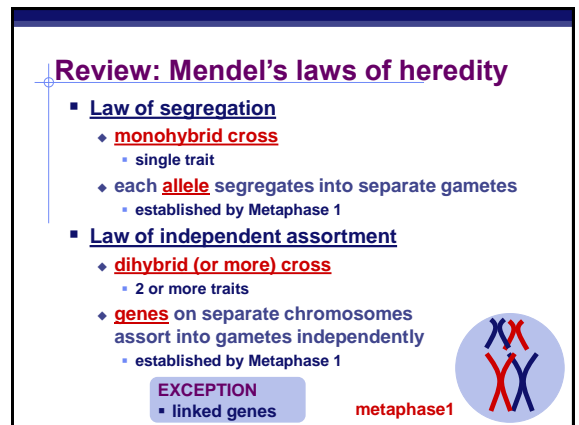
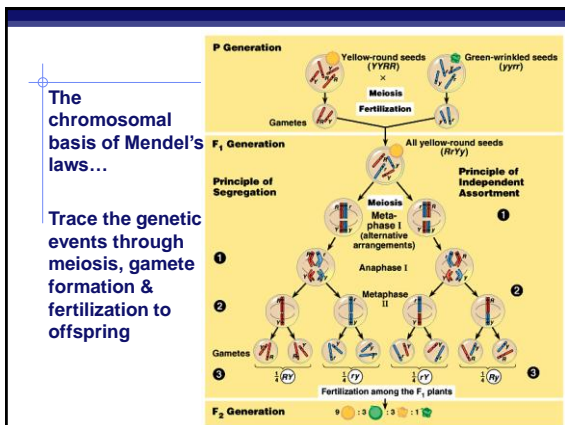
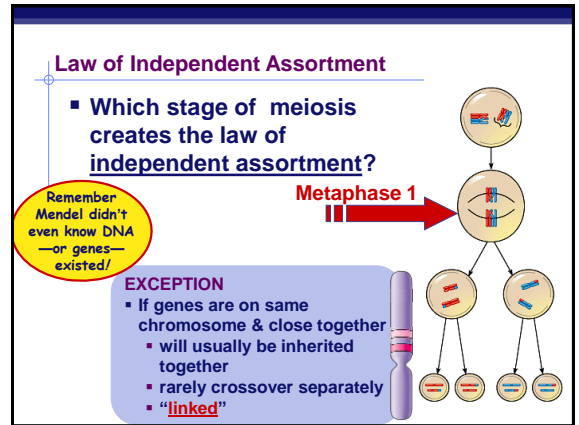
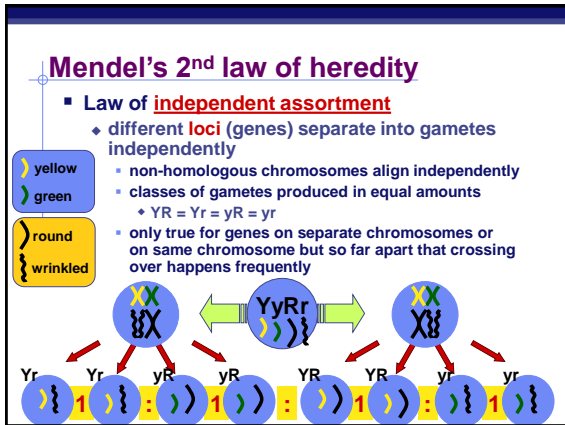
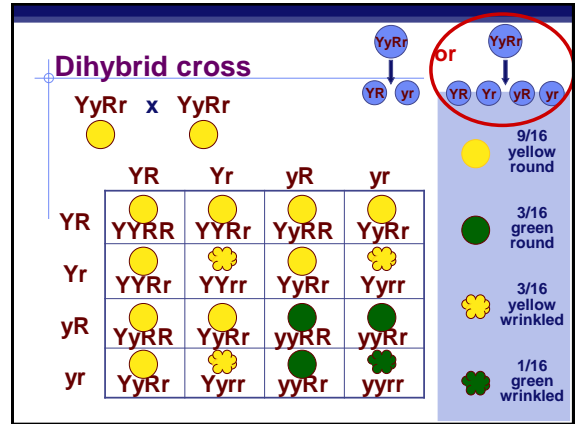
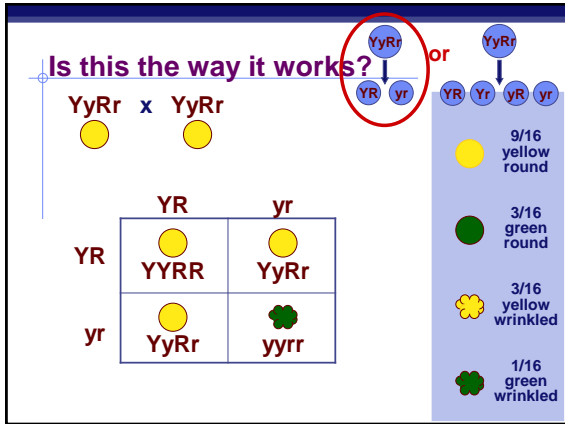
## Dihybrid cross



## What's going on here?

- If **genes** are on different chromosomes...
  - how do they assort in the gametes?
  - together or independently?**





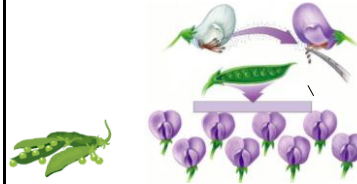
### Mendel chose peas wisely

- Pea plants are good for genetic research
  - ◆ available in many varieties with distinct heritable features with different variations
    - flower color, seed color, seed shape, etc.
  - ◆ Mendel had strict control over which plants mated with which
    - each pea plant has male & female structures
    - pea plants can self-fertilize
    - Mendel could also cross-pollinate plants: moving pollen from one plant to another



### Mendel chose peas luckily

- Pea plants are good for genetic research
  - ◆ relatively simple genetically
    - most characters are controlled by a single gene with each gene having only 2 alleles,
      - ◆ one completely dominant over the other



Any Questions??

