MENDELIAN GENETICS

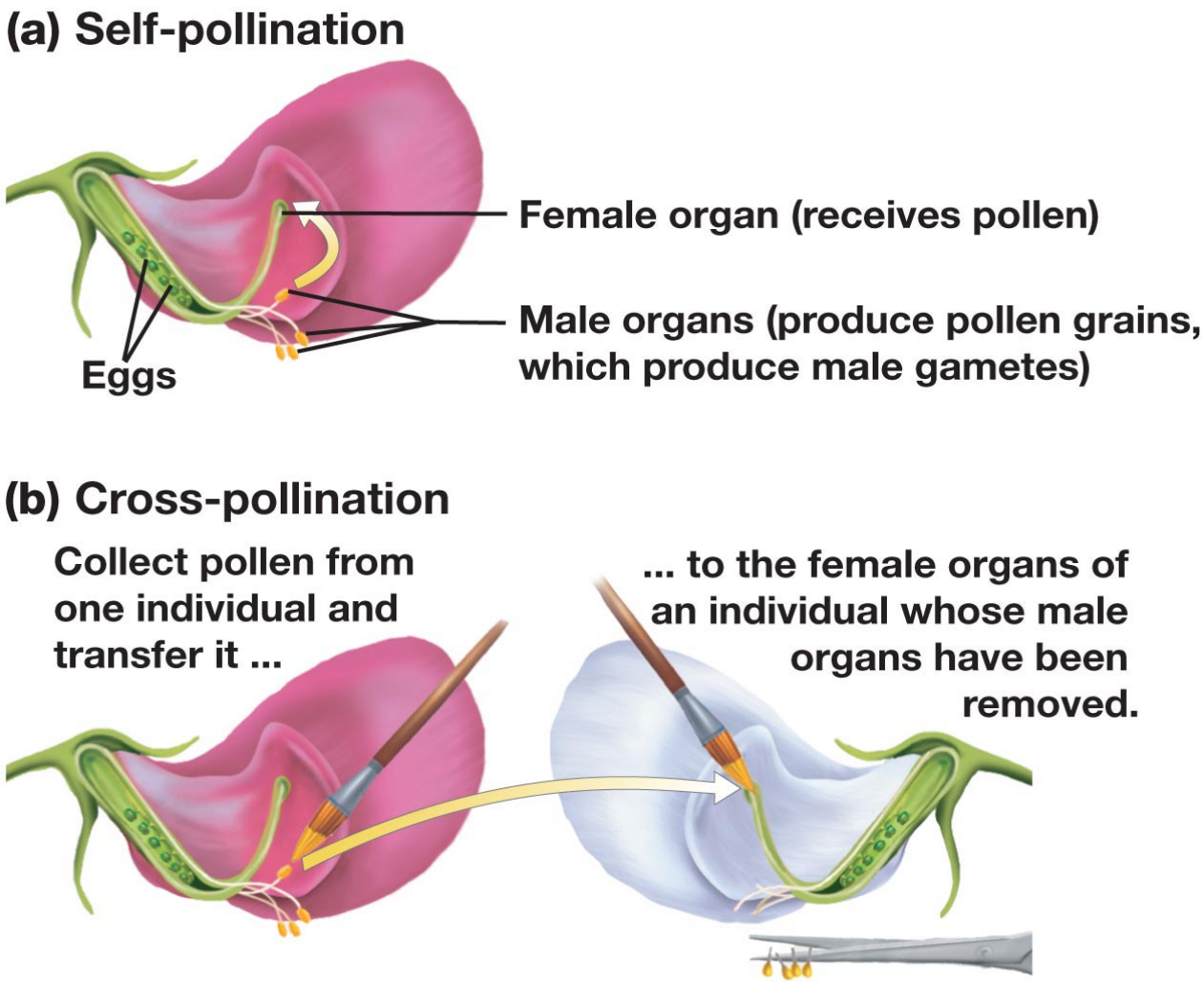
Gregor Mendel

- 19th century Austrian monk
- Interested in heredity
  - Traits from parents to offspring
- Studied the pea
  - Grows quickly
  - Variety of traits
    - Seed color, flower color, seed shape
  - Has the ability to self-pollinate

Gregor Mendel

- Question:
  - How transmission of traits occur?
- Hypotheses
  - Blending inheritance
    - Offspring have intermediate traits
  - Inheritance of acquired characteristics
    - Parental traits are modified and passed on

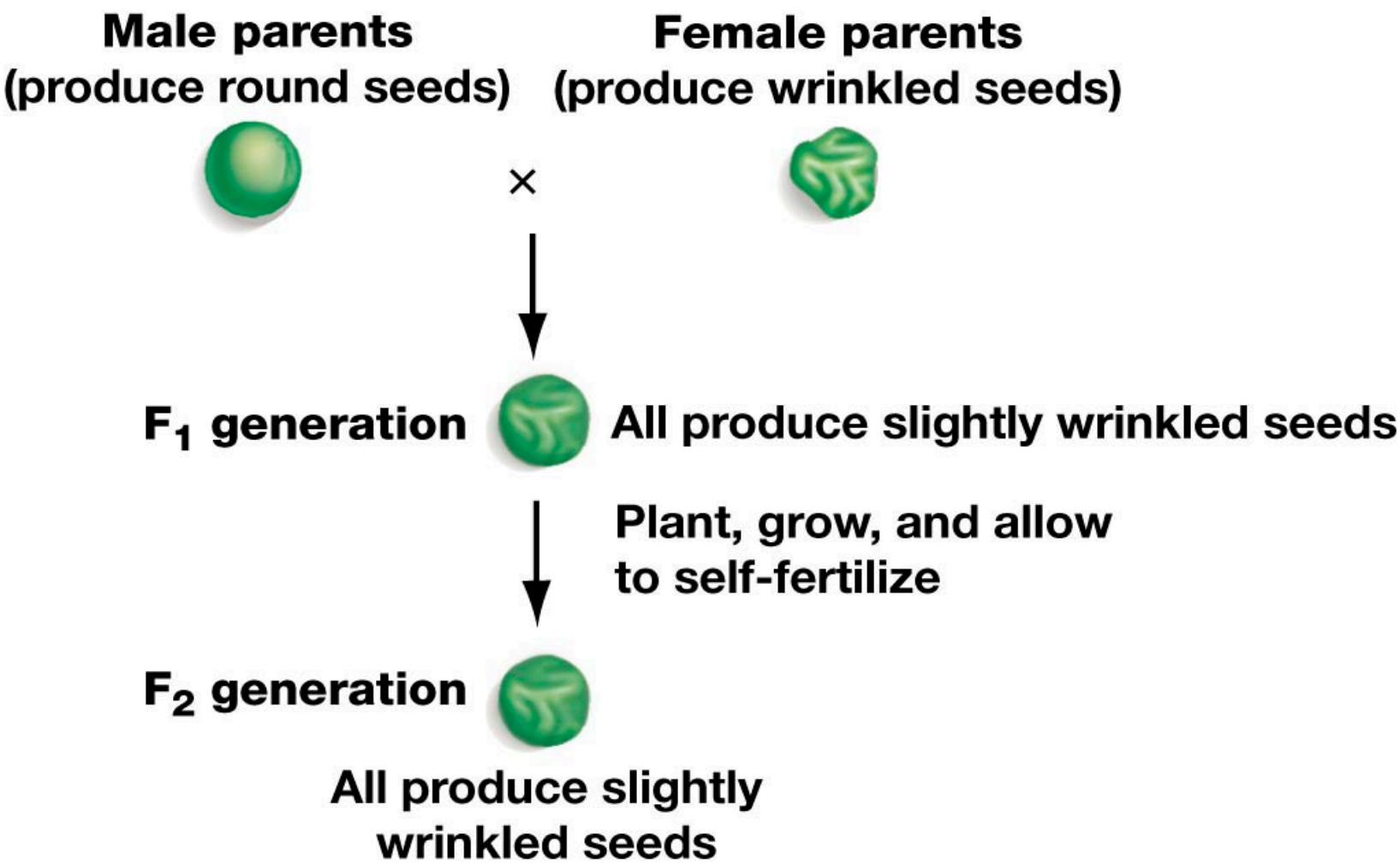
Controlling pollination



True breeding

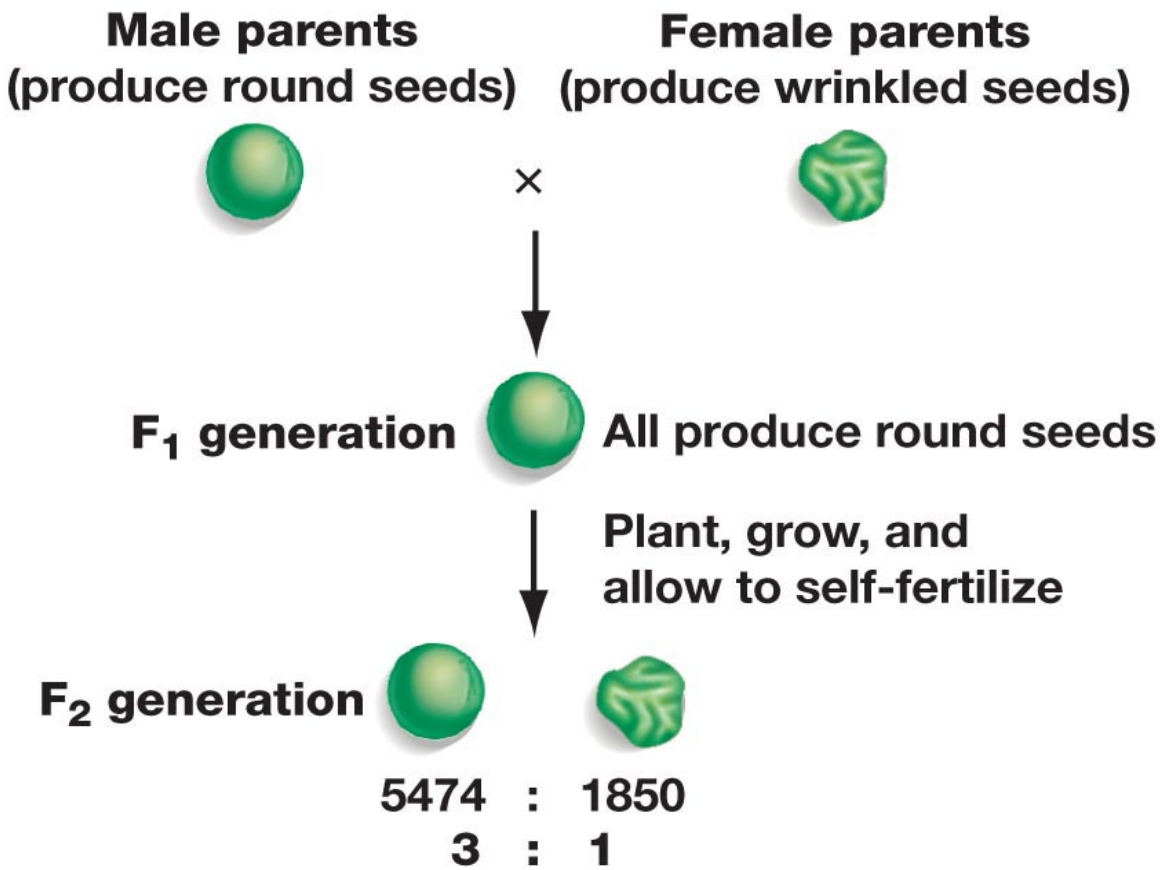
- Mendel work with pure lines
  - Produced identical offspring when self-pollinated
- Created hybrids
  - From two different pure lines
- Followed for 3 generations
  - P – Parent generation (pure)
  - F_1 – First generation
  - F_2 – Second generation

Hypothesis: blending-inheritance



Results of Mendel's 1st experiment

- Crossed plants varying in one trait



Mendel's conclusions

- Blending-inheritance hypothesis not supported
- Determine that round seeds were *dominant*
  - If allele was present, it would appear
  - Recessive phenotype (wrinkled seeds)
    - would only appear if both alleles were recessive
- Prediction:
  - 3 dominant phenotype: 1 recessive phenotype

Mendel's conclusions

- Blending-inheritance not supported
- Developed a model of inheritance

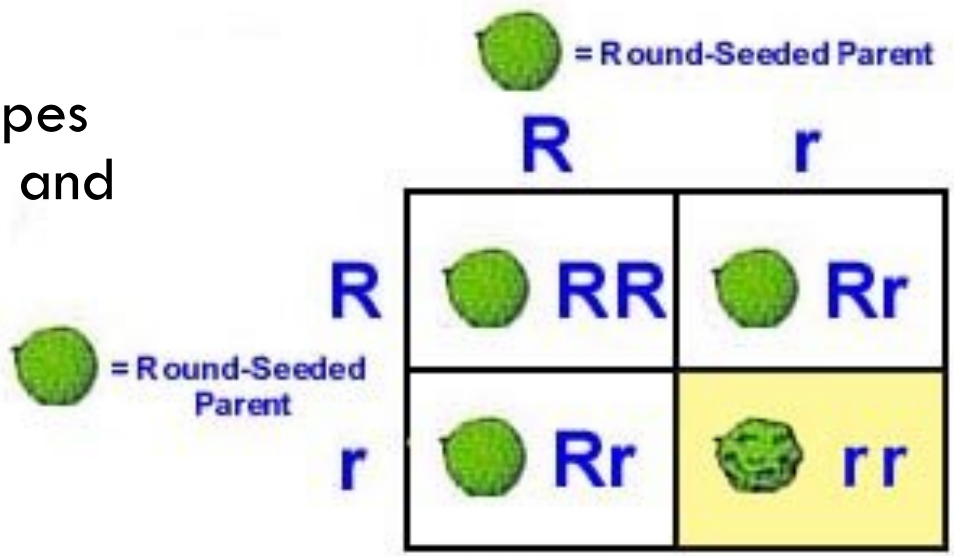
Trait	Dominant Phenotype	Recessive Phenotype	Ratio
Seed shape	5474 round 	1850 wrinkled 	2.96 : 1
Seed color	6022 yellow 	2001 green 	3.01 : 1
Pod shape	882 inflated 	299 constricted 	2.95 : 1
Pod color	428 green 	152 yellow 	2.82 : 1
Flower color	705 purple 	224 white 	3.15 : 1

Phenotype vs. genotype

- *Phenotype*
  - A physical trait of an organism
  - e.g. wrinkled seeds
- *Genotype*
  - The combination of alleles of a gene
    - *SS* (homozygous dominant)
    - *Ss* (heterozygous)
    - *ss* (homozygous recessive)
- *SS* and *Ss* (genotypes) would appear round (phenotype)
- *ss* (genotype) would appear wrinkled (phenotype)

Punnett Square

- Used to predict the genotypes and phenotypes of offspring from a cross
- Steps
  - Write gamete genotypes for one parent on top and other on left
  - Fill each box with genotype by tracing
  - Predict ratios of each possible offspring



Punnett Square

- Practice problems:
  1. What is the expected genotype ratio of the new generation in a cross between a homozygous dominant parent (*AA*) with a heterozygous parent (*Aa*), where *A* is a dominant allele for curved seed pods, and *a* recessive allele for straight seed pods?

Punnett Square

- Practice problems:
  1. What is the expected genotype ratio of the new generation in a cross between a homozygous dominant parent (*AA*) with a heterozygous parent (*Aa*), where *A* is a dominant allele for curved seed pods, and *a* recessive allele for straight seed pods.

Answer

2AA : 2Aa

Punnett Square

- Practice problems:
  1. What is the expected phenotypic ratio of a cross between two heterozygous (*Ff*) plants, where F is the dominant allele which expresses pink flowers, and f is an allele that expresses yellow flowers.

Punnett Square

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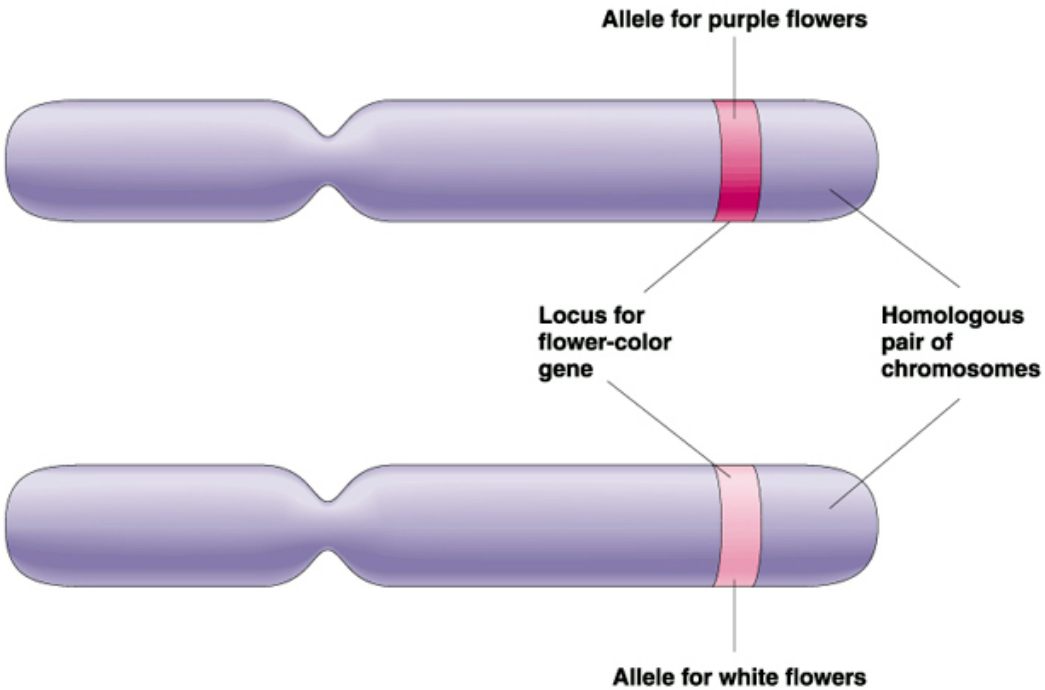
  1. What is the expected phenotypic ratio of a cross between two heterozygous (*Ff*) plants, where F is the dominant allele which expresses pink flowers, and f is an allele that expresses yellow flowers.

Answer

3 pink : 1 yellow

Law of segregation

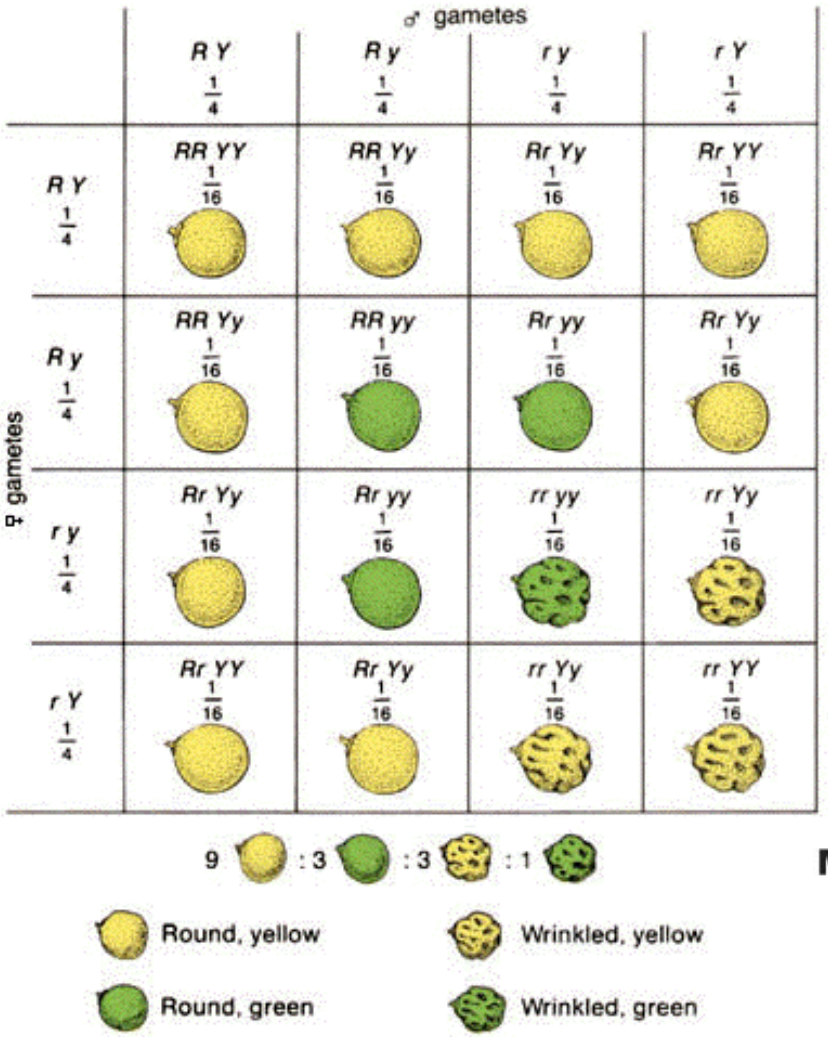
- Individual possesses a pair of alleles and that each parent passes a randomly selected allele to their offspring



Independent vs. dependent assortment

- Independent assortment
  - Punnett square of dihybrid cross predicts
    - 9 different genotypes
    - 4 different phenotypes
      - Ratio of 9:3:3:1
- Dependent assortment
  - Genes are connected to each other
  - Punnett square of dihybrid cross predicts
    - 3 different genotypes
    - 2 different phenotypes
      - Ratio of 3:1

Mendel's dihybrid cross



- Crossed plants with two traits
  - Seed color & shape
- Results suggest that alleles were *independently assorted* relative to the other trait, F_2 would be
  - 9:3:3:1
- If *dependently assorted* F_2
  - 3:1

Mendel's results

F_2 phenotypes				
Number	315	108	101	32
Fraction of offspring	9/16	3/16	3/16	1/16

Law of independent assortment

- Genes for separate traits are passed independently from parents to offspring
- The selection of one trait has nothing to do with the selection of another
- Pea example
  - Pea color is not correlated with wrinkledness

Mendel's model of inheritance

1. Alternative versions of genes (=alleles) account for physical variations
2. For each characteristic, organisms get one allele from each parent
3. If two alleles differ, the dominant allele determines the physical appearance
4. Two alleles separate during gamete formation

Incomplete dominance

- Traits "bleed"
  - Dominant homozygous
    - RR: extreme (dark)
  - Heterozygous
    - Rr: intermediate (medium)
  - Recessive heterozygous
    - rr: extreme (white)

(a) Flower color is variable in four-o'clocks.

(b) Incomplete dominance in flower color